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The Society is not responsible for statements or opinions advanced in papers or discussions at its meetings or in articles in SAE Journal.

A complete index of all Journal technical articles, from January through December, will appear in the December issue. All Journal technical articles are indexed by Engineering Index, Inc. SAE Journal is available on microfilm from University Microfilms, Ann Arbor, Mich.

Briefs of SAE PAPERS

Presented here are brief digests of recently presented SAE papers. These papers are available in full in multilith form for one year after presentation. To order, circle the numbers in the "Readers Information Service" blank on page 6 corresponding to the numbers appearing after the titles of the digests of interest to you.

AIRCRAFT

Reliability Design Criteria, J. M. BROWN, H. L. LEVE, P. H. WHITE. Paper No. 101V. Approach taken by Hughes Aircraft Co. and consideration of various design criteria which include concepts of environments, strengths, strength-environment separation factors, and allocation of unreliability values to elements of system; possible design procedures resulting from three types of testing; concepts and techniques for evaluating reliability are illustrated in design of mechanical element.

600 F Hydromechanical Constant Speed Drive, E. W. KRUGER, S. S. BAITS. Paper No. 102T. Requirements of constant speed drives to obtain 400 cycle a-c power for use on aircraft with speeds of Mach 3 or above; development program of electrical generating system built by Sundstrand Aviation Div.; tabulation of requirements and factors considered; block diagram of hydrostatic transmission system with mechanical differential feature; choice of fluid; electrical controls and other elements; friction and wear evaluation tests.

600 F Constant Speed Drives — Mechanical Traction Type, C. D. FLANIGEN. Paper No. 102U. Problems and achievements experienced during design and development, by Lycoming, of system consisting of variable ratio transmission, lubrication and cooling system, mechanical primary speed control, electronic trim control, automatic paralleling control, and load sharing system for paralleled a-c generators; selection of transmission materials and lubricants; power capability; comparison of mechanical and electrical development approaches.

600 F Airborne Electrical System, J. J. PIERRO. Paper No. 102V. Features of Project HOTELEC for developing major components of airborne generation and distribution system: selection of team approach for each major component with complete system divided into 12 separate development programs; individual programs and responsible teams outlined; technical management approach taken by North American Aviation, Inc. in charge of directing and coordinating whole program; material developments; subcomponent developments; major component designs.

JT12 Pratt & Whitney Aircraft's 3000 Lb. Thrust Turbojet Engine, D. G. PHINNEY. Paper No. 103U. Background and development program; list of current applications for engine; selection of airflow capacity of engine at approximately 50 lb/sec; factors considered in choice of 9-stage compressor to maintain max relative Mach number at 1.0 and average stage pressure ratio at 1.24; use of IBM calculation in compressor design procedure; comparison of JT12 with JT4 relating to various design features.

Future Applications of Ducted Fan Powerplants, N. BURGESS, A. P. FIORETTI. Paper No. 103V. Basic concept of ducted fan engine; review of mechanical concepts presently used; three basic arrangements are shown; propulsive efficiency for turbojet, turboprop and ducted fan engines is investigated with respect to basic parameter, i.e., specific engine net thrust based upon gas generator air-flow, referred to as Fn/Wgg; it is shown that ducted fan is superior to turboprop for high subsonic cruise and superior to turbojet in four areas; developmental possibilities.

Elevated Temperature Testing of Flight Vehicle Materials, A. V. LEVY, E. C. BERNETT. Paper No. 104T. Test work carried out by Materials and Process Laboratory of Marquardt Corp. to explore impact of new environments to which material is subjected such as rapid heating to extremely high temperatures, rapid, constant, and vibrational loading, and combinations thereof under atmospheres of partial vacuum, corrosive media, air, particle bombardment, and radiation; factors taken into account in determining strength of material.

Applications of Current Materials to Hot Airframe Design, M. B. DUNN,

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SAE JOURNAL, February, 1960, Vol. 68, No. 2. Published monthly except two issues in January by the Society of Automotive Engineers, Inc. Publication office at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 485 Lexington Ave., New York 17, N. Y. $1 per number; $12 per year; foreign $14 per year; to members 50¢ per number, $5 per year. Entered as second class matter, Sept. 15, 1948, at the Post Office at Lancaster, Pa., under the Act of Aug. 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of Feb. 28, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1918. Additional entry at New York, N. Y. Second class postage paid at Lancaster, Pa. and additional office N. Y. C.

M. D. MUSGROVE, O. T. RITCHIE. Paper No. 104U. Design of "unprotected" structures subjected to severe thermal environments; structures discussed are built-up "flat plate," cylindrical and conical shells, and thermally nonredundant configurations which do not employ artificial cooling systems, but exploit radiant cooling and thermal characteristics of materials; additional design factors are sonic fatigue, panel flutter, aerodynamic smoothness, and general flutter; material selection.

Analytical Techniques for Prediction of Temperature Distribution of Cold Plate Equipment Conditioning System, T. S. NEWBY, G. M. BELLER. Paper No. 105T. Miniaturized aircraft electronic equipment requires cooling by cold plate techniques; lumped network approach used in problem of finding temperature distribution; two methods are presented; matrix method requires that heat balance equations for several lumps be arranged in matrix array; inversion at matrix produces lump temperatures; particulars of alternative thermal analyzer method.

Optimum Joint Design for High-Temperature Honeycomb Panels, F. J. FILIPPI, B. LEVENETZ. Paper No. 99U. There are two basic approaches to design of joints in optimization of sandwich itself: pictorial design procedure, concerned with optimizing one type of structure such as honeycomb sandwich, and analytic design differing in that optimization is primarily interpreted as achieving best load transfer at lightest weight, irrespective of type of structure necessary to accomplish transfer; both approaches are discussed; pertinence to aircraft and missiles.

Structural Foil for Hot Parts, M. J. BREITENBACH, B. LAKE. Paper No. 99T. All spotwelded, foil-gage structural material "MiniWate," developed by Ryan Aeronautical Co., is single skin, corrugation stiffened structure designed to eliminate blind spot welds, simplify inspection, and reduce manufacturing costs; basic technique and welding machines can be used to handle most metals such as L605, AM355, 15-7Mo, 17-7PH, A286, 321 and 301 steels, pure Ti 6AL4V, and all Beta alloys; sample products and design problems; pertinence to aircraft and missiles.

Mass Produced, All Welded, High Temperature Sandwich, J. W. SCHEUCH. Paper No. 99V. Development of production process and machines for fabrication of resistance welded steel sandwich called "Spacemetal," made by Missile Div., North American Aviation, Inc., for aircraft and missile applications; background of process, description of core forming machine and welder where corrugated core and facing sheets are joined; quality control process employed for inspecting finished product; material properties and applications.

Material and Structural Damping for Vibration Control, B. J. LAZAN. Paper No. 100U. Importance of near-resonant vibrations in aircraft or space vehicle structure and role of system damping; component parts are analyzed within framework of hysteretic damping associated with interface slip or Coulomb friction, and shear strain in adverse layer at interface; analytical concepts for maximizing sheer damping in interface adhesive by design optimization procedures.

Selection of Methods and Instruments for Vibration and Shock Testing, T. P. RONA. Paper No. 100V. Principles governing establishment of rational shock and vibration testing programs such as for high performance aircrafts and space vehicles; definition of test objectives which comprise proof of compliance, design and workmanship; parameter adjustment, and endurance life prediction; establishment of logical flow pattern and block diagram; elements of component analysis, test machinery and instrumentation; consistency and compatibility checks.

Increased Reliability of Aviation and Missile Electronics by Use of Damped Structures, J. E. RUZICKA. Paper No. 100Y. Increased reliability of aviation and missile electronics depends on control of elastic body resonances that amplify transmitted vibration; properties of simple lumped parameter relaxation system are used to evaluate fundamental mode characteristics of given relaxation damped structure design; results of dynamic response tests indicate that structures using visco-elastic damping materials appear promising.

Considerations in Design of Shock and Vibration Tests, I. VIGNESS. Paper No. 100X. Tests are usually established on basis of maximum intensities of shock and vibration that occur in field and for locations at which equipment may be used; it is shown that shock and vibration specifications based on maximum values of measured field environment may cause incorrect tests; effects of equipment-foundation reactions; development of vibration specification for hardware for new type

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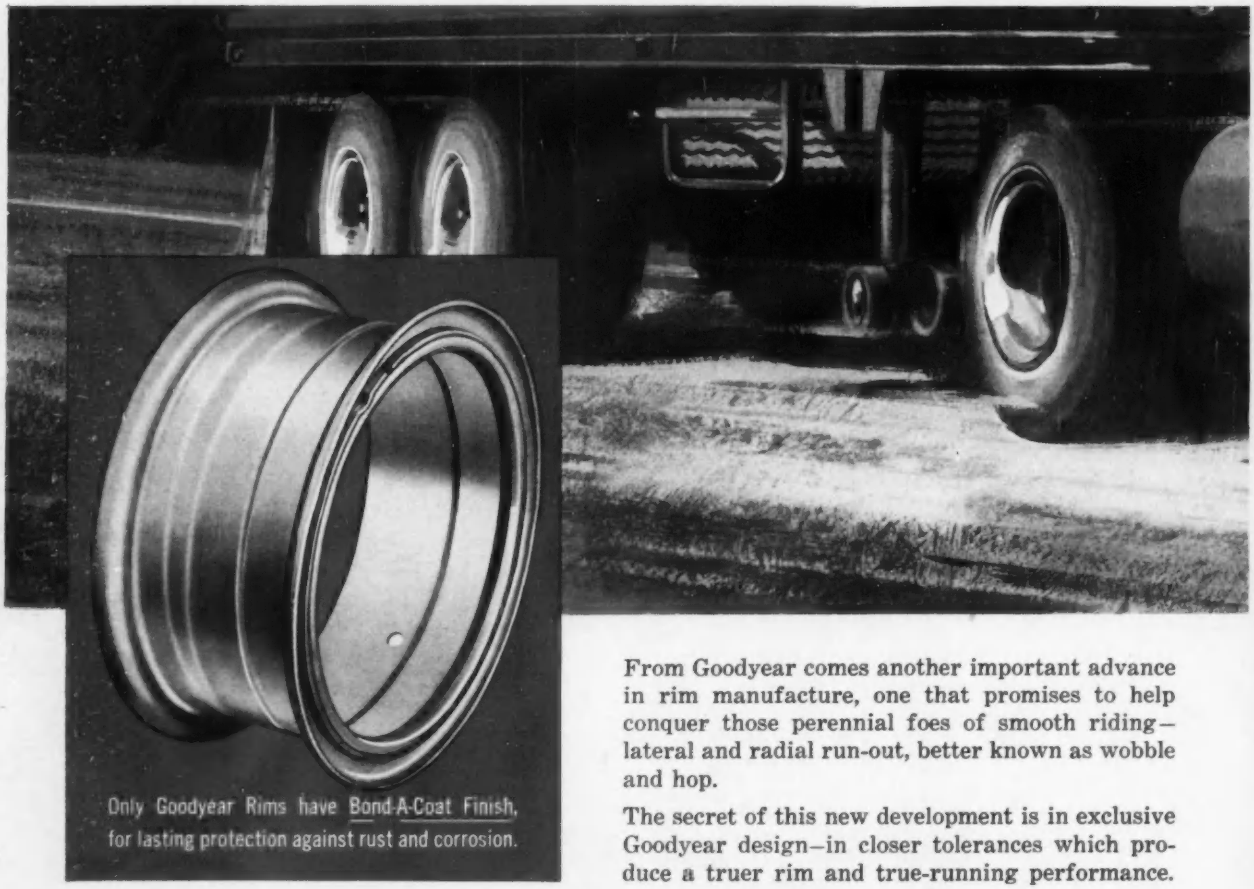

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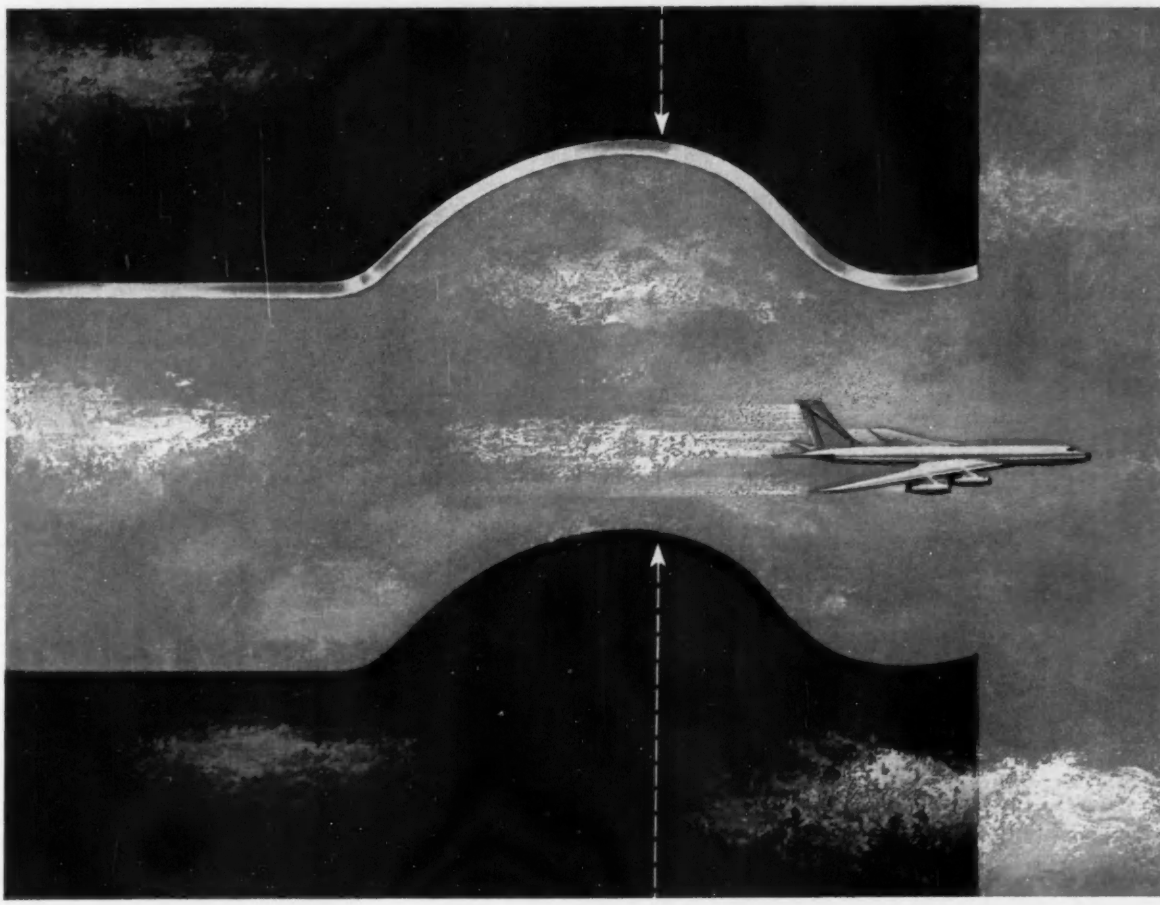

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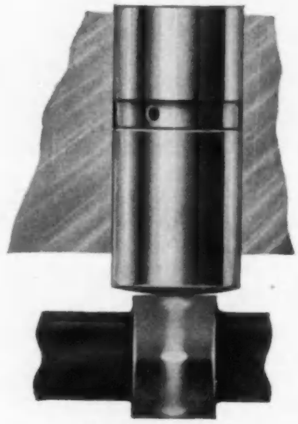

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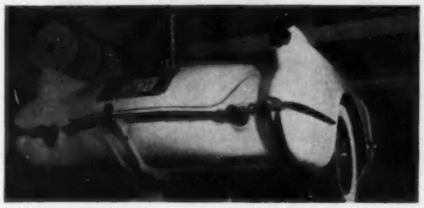

All photographs are unretouched.

It was built in June, 1954, for presentation at the National Plastics Exhibition in Cleveland, and has had continuous, hard use ever since.

NOTICE THE PERFECT CONDITION OF THE BODY.

This car has been driven 125,000 miles. For three years it has been driven in and around Ohio — where road chemicals are in use five months of the year. For two years it was in Florida's salt air . . . with "MFG" Boat salesmen trailering boats behind it most of the time.

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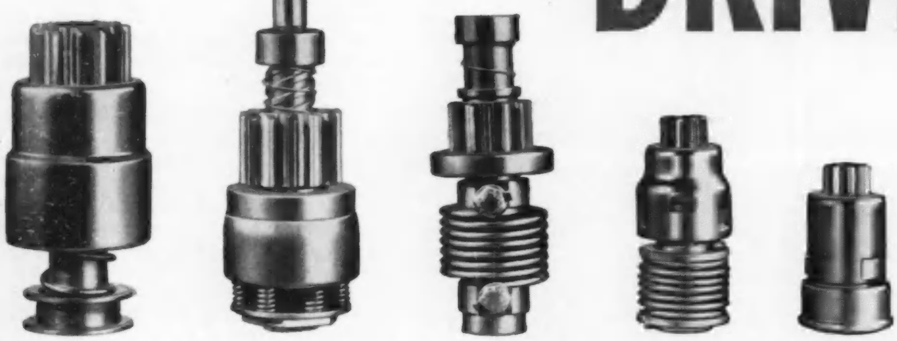

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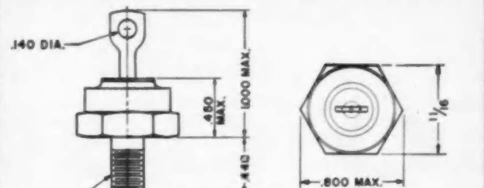

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1N1192A	22A	100V	150°C	1.2V at 60 amps.	5.0 MA
1N1193A	22A	150V	150°C	1.2V at 60 amps.	5.0 MA
1N1194A	22A	200V	150°C	1.2V at 60 amps.	5.0 MA
1N1183A	40A	50V	150°C	1.1V at 100 amps.	5.0 MA
1N1184A	40A	100V	150°C	1.1V at 100 amps.	5.0 MA
1N1185A	40A	150V	150°C	1.1V at 100 amps.	5.0 MA
1N1186A	40A	200V	150°C	1.1V at 100 amps.	5.0 MA at 150° C case temperature and rated PIV

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H&R buys more ROADRANGERS

As part of a fleet expansion and modernization program, Husmann & Roper Freight Lines, Inc., St. Louis, recently purchased 16 new International Model DCOT-405 Tractors equipped with 195 hp diesel engines and 10-speed Fuller R-96 ROADRANGER Transmissions. The new-equipment purchase brings to 50 the number of single-stick, semi-automatic Fuller ROADRANGERS employed in the H & R fleet.

Husmann & Roper President Guy Roper says, "In the past we have purchased several different models of trucks and tractors with the 8-speed R-46 ROADRANGER, and we are now using the R-96 in our more powerful units. Our road drivers tell us that they prefer the ROADRANGER Transmissions because of the easy shifting and short, even steps between ratios to handle grades."

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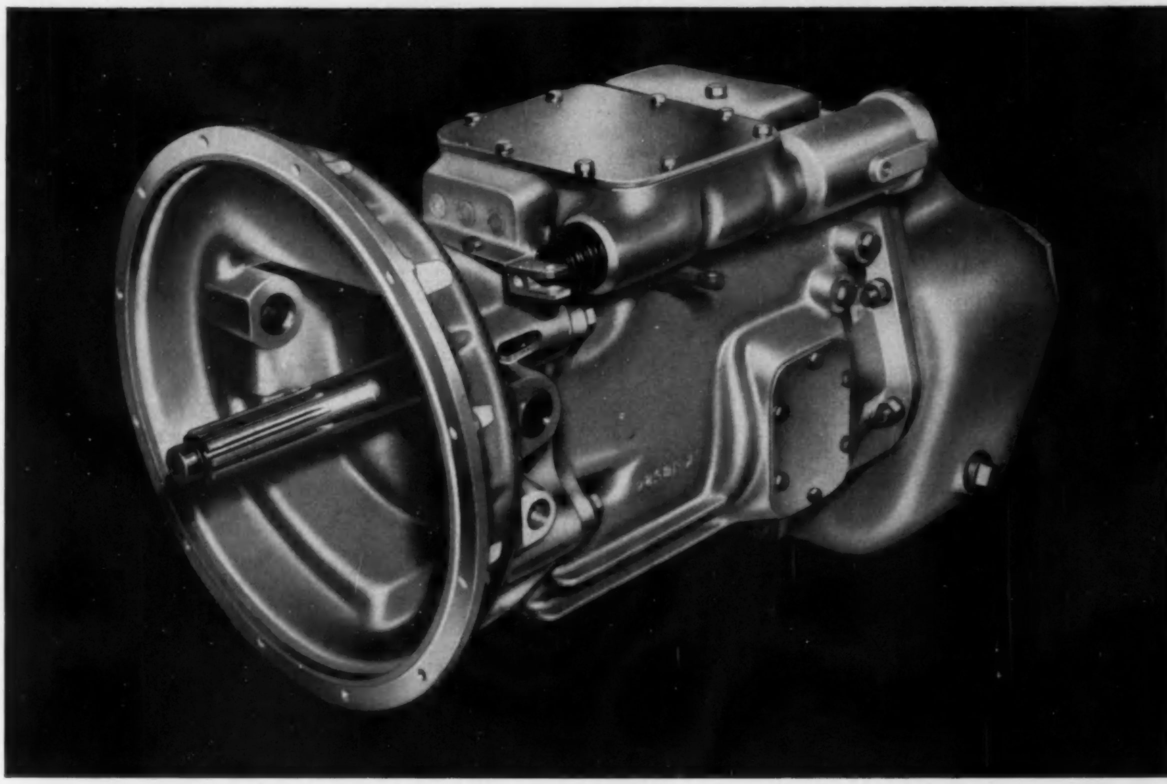

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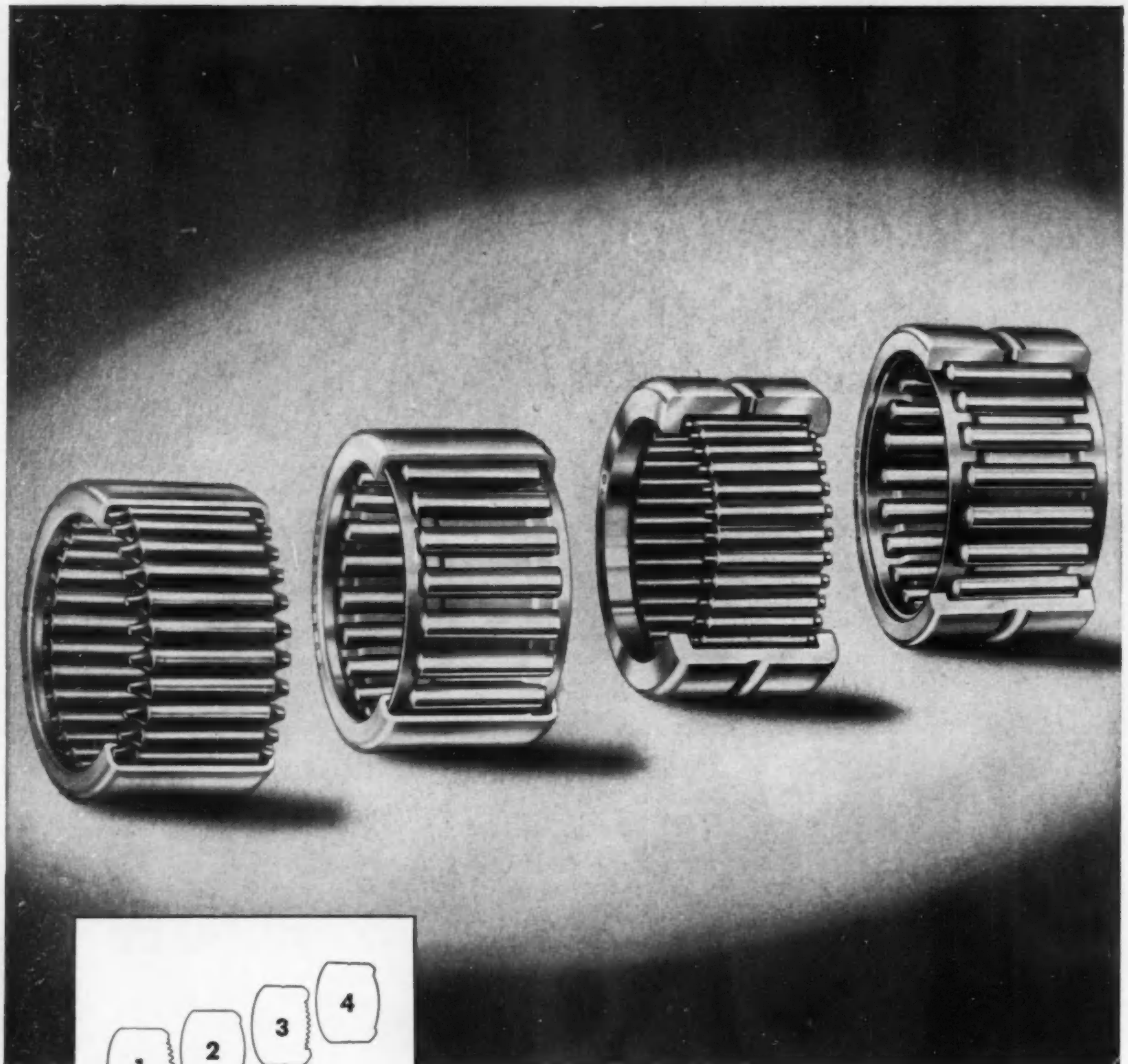


SAE
JOURNAL

For Sake of Argument

Let the Engineer Speak for Himself . . .

THE SPECIALIST who can speak and write effectively will always carry the flag of knowledge farther and faster than any nontechnical wordwizard. Only an engineer can tell an engineering story most effectively—whether the audience be technically trained or not.

This is not to say that a given engineer's thoughts and facts cannot sometimes be better arranged than when he first commits them to paper. Nor is it to say that, in a given case, a nontechnical writer may not be of great help in making that rearrangement. But unless the engineering story comes originally from the mind and the heart of the engineer, it won't turn out to *be* an engineering story. It may turn out to be *about* engineering; but it won't *be* engineering. The statement in outline of the ideas and facts an engineer wants to convey should always be his own. Nontechnical help at this point is usually fatal to production of worthwhile material . . . and the first draft of the article, paper, or report had best be the engineer's very own, too. The wordsmith-helper can contribute constructively only when he works with facts and ideas already selected, sorted, and appraised by an engineer. He may on occasion be able to help the engineer to think straight; but the engineer has to do the thinking.

Most will grant these necessities for production of papers for engineering societies, reports from engineers to management, and articles for technical publications. Fewer will agree about their potency in preparing similar material for the general public. . . . Besides, engineers themselves usually are loath to take on the latter chore.

To the extent that the engineer insists on doing all of his own technical writing, however, he will gain increased respect from his fellow engineers—and give the general public a break, too.

Norman G. Shidle

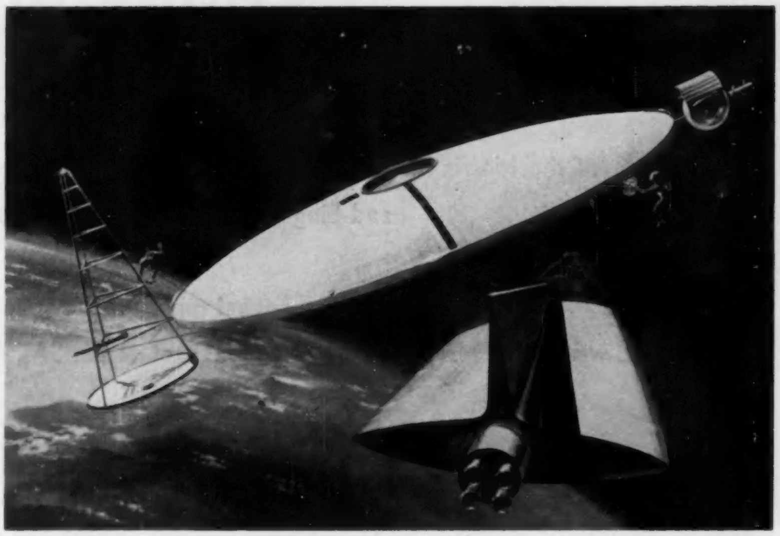
1960
Annual Meeting
See p. 98

chips

from SAE meetings, members, and committees

NOT BUCK ROGERS STUFF, but an artist's conception of how a reconnaissance vehicle would be assembled 1000 miles in space.

The "moon" or large saucer-like vehicle, which would orbit Mars and beam back valuable technical data, would be about 40 ft across and weigh approximately 600 lb. The objects attached to each side are to collect the data and send it back to Earth. The rocket ship is of course used to transport men and materials from Earth to this space platform. This Martian "Explorer" is one of several studies being conducted by Boeing scientists to provide background and knowledge of the type needed for the Space Age.



IT IS ESTIMATED that 75% of all parts made on machine tools in the United States today are run in lot quantities of 20 pieces or less.

ELECTRONICS has played a major role in the development of guided missiles. The amount spent on military electronics has practically doubled in the past 4–5 yr. In 1955, for example, electronics accounted for $3.3 billion of total defense spending. In 1959 electronics accounted for an estimated $6.0 billion.

There is every indication that this trend will continue as weapons systems increase in size and complexity and their electronic content continues to grow. A few years ago, approximately 15% of the cost of military aircraft was for electronics. About 50% of the cost of first generation missiles is for electronics. The new larger missile systems, including all the complex ground equipment and auxiliary equipment will have about 60% of their cost in electronics.

A TURBINE ENGINE CAN MAKE THE TRANSITION FROM KEROSENE TO JP-4 FUEL, but its fuel meter can not. That's because present meters are volume meters. What's needed is a good, reliable mass flow meter for fuels, a meter which can detect the differences in specific gravities of the various fuels around the world.

DETECTION SYSTEMS for vehicles with respect to the roadway can be made simple and reliable through proper use of radioactive energy. Guidelines within the roadway itself, by which a vehicle may automatically be controlled, have been considered using relatively small amounts of radioactive material buried within the surface of the concrete. This arrangement is said to produce a safe and reliable control system.

CORROSION INHIBITORS can be added to the road salts used on icy streets to cut down car and truck body damage. However, the NYC Sanitation Dept. reports that the inhibitors cost more than the salts and chemical themselves.

1960 European Automobile Engineering Trends

Interesting features of the new European models, including details of the Morris Mini-Minor suspension and the new automatic transmission for Hillman and Singer, are revealed in this interpretative analysis, based on the 1959 European automobile shows.

This is the third such annual report of the engineering highlights of the European shows written by Mr. Pershouse at the request of the SAE Overseas Information Committee.

by

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IN the Fall of 1959 the full range of important European car shows took place. In order of appearance these were: the bienniel Frankfurt display, Paris, London's Earl's Court, and the Turin Show. Latest returns, both official and unofficial, indicate that attendance increased at all these shows compared with the last occasion on which they were held, although 1955 still holds the record as far as London is concerned.

The shows following Frankfurt provided an unusual feature of considerable interest in 1959, as the new Corvair and Falcon appeared for the first time at Paris, and the Valiant arrived about halfway through the London Show.

These new, smaller American cars attracted a great deal of technical interest; the more unusual arrangement of the Corvair drawing large crowds, particularly during its first appearance at Paris.

Previous trends continued

Certain of the trends in European car practice that have been noted in previous similar articles in

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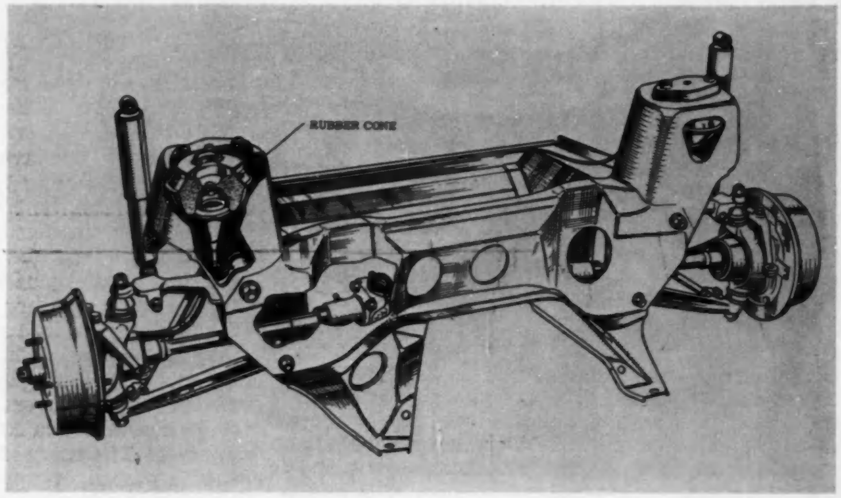
Fig. 1 — New Fiat twin-ohc 1500 chassis with body by Bertone.

Fig. 2 — Front drive and suspension unit on Austin 7 and Morris Mini-Minor. Note rubber cushions in inner universal joints and conical rubber springs that weigh only 2 lb and absorb 2000-lb load.



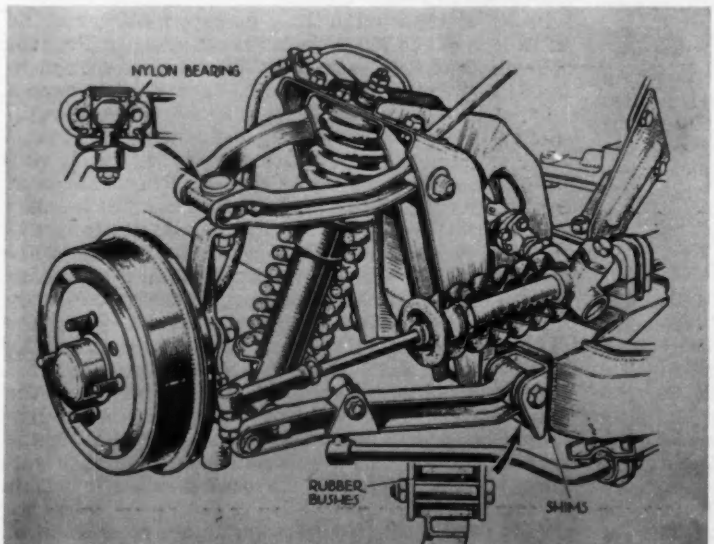


Fig. 3 — Details of Triumph Herald front end showing use of rubber and nylon to eliminate lubrication points.

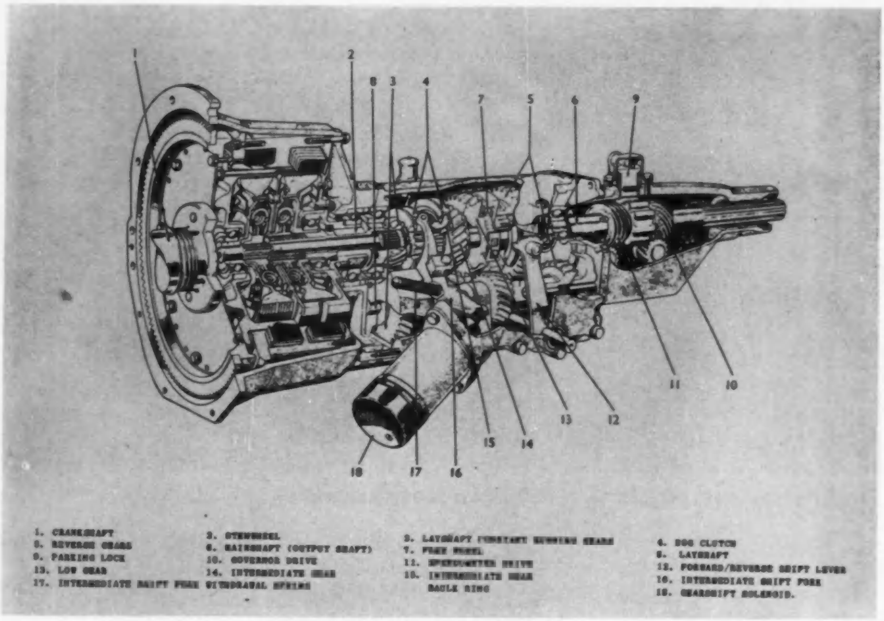


Fig. 4 — **Easidrive transmission** is used on Hillman Minx and Singer Gazelle.

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SAE Journal were still in force at the 1959 shows. These trends included: the tendency to up-grade mini-cars as to engine, package-size, and cost from unduly modest beginnings, decreasing emphasis on automatic clutches in favor of genuine automatic transmissions, further interest in diesel-engine passenger cars, use of Italian body-builders' names and skills in an attempt to "glamorize" production car styling, and the increasing use of disc brakes by British makers, coupled with the first use of these by a German producer. In all, some 24 British makers and 43 different models, of which not more than four can be excluded as purely racing machines, now use this type of brake either as an option or as standard equipment. In one or two cases there are obvious efforts to provide special shielding against road dirt.

Importance of individual 1959 shows

Frankfurt — At Frankfurt about the normal quantity of new models appeared. The DKW Junior, apparently Mercedes' bid to enter a lower price class, represents quite a lot of car for its low price in the German domestic market. Mercedes' own restyled 220 car constitutes a step forward from the distinctly more conservative appearance of the old model, while Borgward introduced a new large 2.3 Litre (2240 cc or 136.7 cu in.) car in addition to continuing with the smaller well-known Isabella. Opel's Kapitan is new, with improved styling and a larger 2605 cc (159.0 cu in.) engine, while the well-known Opel Rekord car is now available with three engine sizes, the 1200 (1205 cc or 73.5 cu in.), the 1.5 (1488 cc or 90.8 cu in.), and the 1.7 (1680 cc or 102.5 cu in.).

Other new models at Frankfurt included a new, larger Lloyd Arabella car, the BMW 700 (replacing the smaller 600 model), more emphasis on the larger front-engine 700 Goggomobil cars (now known as the Isar models) and some front-end restyling in the case of Porsche.

Paris — at Paris there were no important new models, but improvements to Renault Dauphine suspension and Simca Aronde rear suspension were of interest. The entry of Peugeot into the small diesel-engine passenger-car field is noteworthy. The engine is a small 4-cyl unit of 1816 cc (110.8 cu in.) and is listed as an option in the well-known 403 car at the extra cost of 250,000 French Francs ($510). Peugeot believes that this extra cost should be regained in some 18,000 miles of operation. Facel Vega showed a new small sports car with a twin-overhead-camshaft 4-cyl engine of 1600 cc (97.6 cu in.). In convertible coupé form it is attractively styled on very Italian lines and may fill a need in France, even at the high local price of 1,950,000 Francs ($3980). The very attractive Renault Floride, using Dauphine mechanical components, which was introduced and described in 1958, is now in production and still looks very good as a small sports-type convertible when seen under conditions of normal road use. The same car has just been introduced in the U. S. under the name "Caravelle."

London — The course of the year 1959 and the London Show in October saw more, and more important, new models than have been produced by the British Industry in any one year since the war. Many of these changes are described later in this report.

Turin — At Turin there were no new models of importance, with the exception of the Fiat 6-cyl

1800 and 2100 models, which had been introduced at Geneva in March. The usual, excellent coachwork by numerous Italian makers was on view, while the twin-ohc 1500 Fiat (first shown in 1958 with Pinin-Farina coachwork) appeared this year with attractive bodies by several different makers (Fig. 1). In the realm of very-high-performance cars, Maserati showed a new and very imposing 5000 series car having a body by Touring and a 90-deg V-8 engine with twin-overhead-camshafts of 4935-cc displacement (301 cu in.). This develops 340 bhp at 6000 rpm, and the car has a claimed top speed of around 145 mph.

Turin saw a basic innovation in tire design with the announcement of the new BS3 Pirelli tire, which is described and illustrated later in this report.

Features of 1959 London show

Many changes took place during 1959 in the case of the important British Motor Corp.'s numerous makes of cars. Most of the Austin, Morris, Riley, and Wolseley models were completely restyled, using a common body designed by Pinin Farina, with relatively minor exterior appearance differences. The cars so derived are much improved in styling compared with the models which they replaced, but it is felt that the unavoidable similarity in appearance between them may rather quickly become monotonous. The Austin A40 car introduced in 1958 is unchanged but is now available in station wagon as well as in sedan form.

BMC also introduced an original and interesting new small car to be known both as the Austin 7 and the Morris Mini-Minor. The car has many unusual features, not the least of these being the fact that it is about the first mini-car to appear with a more or less normal in-line 4-cyl water-cooled engine of a size (848 cc or 51.7 cu in.) adequate to provide more than a substandard road performance; it has a maximum speed in the neighborhood of 80 mph, with gasoline economy in the order of 40 mpg. Unusually small, 10-in. wheels placed at the extremities of the layout make some 80% of the overall length available for passenger and luggage space. Actual trunk space is small, but four people can sit comfortably in the car, and there is room for many small packages.

The engine is transversely mounted and incorporates a 4-speed transmission in the engine sump, which is lubricated by the engine oil. With this engine location the front wheels are driven (Fig. 2). As a corollary of the transverse engine location the fan blows air through the radiator core and out through a series of slots in the interior wall of the front fender. It may be noted that critical cooling conditions usually occur at relatively low speeds on mountain gradients, often with a following wind. In these circumstances ram effect is not a factor. BMC also states that, as a result of discharging cooling air into this low-pressure area, flow is increased to the extent that the radiator size can be reduced 20%. All mechanical components of the car are carried on front and rear bolt-on subframes and the suspension is quite original, relying on the use of rubber cones rather than metal springs. It is claimed that the configuration of these rubber cones, backed by steel, varies the ride to deal satisfactorily with light or heavy loads. A short ride in this car demonstrated lively performance but rather a hard feeling to the suspension.

Ford made some important model changes, introducing a completely new Anglia model with an ohv 4-cyl 997 cc (60.8 cu in.) powerplant, which has also been installed in the Prefect model, otherwise substantially unchanged. A feature of the Anglia styling, unusual in a small car, is the rear window arrangement sloping forward from top to bottom. The car has a lively and smooth performance. The old Ford Anglia with side-valve 1172 cc (71.5 cu in.) engine has been down-graded in list price to replace the old Popular model, whose design dated from many years ago.

The Standard Co. introduced a new series of Triumph Herald cars during 1959. The bodies of these cars, a 2-door sedan and coupé, owe their styling to Michelotti and are unusual in that the seven main body assemblies are bolted rather than welded together. As a result of this practice Herald owners enjoy some concession on insurance premiums from English insurers. At the time of its introduction this car was the first potentially high-volume English car to have appeared with independent suspension on all four wheels. The layout consists of coil springs and wishbones in front and swing axles with one transverse leaf spring at the rear. Another original feature lies in the attempt to eliminate lubrication points in the suspension and steering on this car (Fig. 3). In the case of the suspension, rubber bushings are used for the front inner wishbone bearings and nylon bushings for the top outer ball-type joint and for the lower outside joints. These are of trunnion type and include threaded aluminum-bronze bearings to conform to steering movement. The kingpin is hollow and has to be filled with hypoid oil

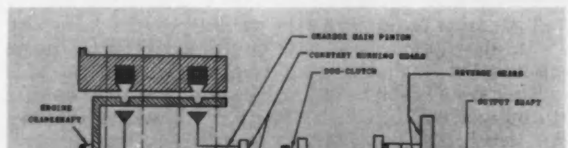

Fig. 5 — **Power path** of Easidrive transmission.

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at long intervals. The small vertical movement of the kingpin distributes this lubricant by pumping action. At the rear, rubber bushed radius-rods take care of brake reaction, while the hypoid-bevel rear axle is mounted to the frame. The drive-shafts themselves act as the lower arms of the suspension system, and the transverse leaf spring forms the upper arms.

In addition to the foregoing, a variety of new models appeared during 1959, or at the London Show, as follows: Sunbeam Alpine, A. C. Greyhound, Armstrong Siddeley Star Sapphire Limousine, Aston Martin DB4 G. T., Daimler SP250 V8 sports car and V8 Majestic Major, Rover 100 model, Rolls-Royce and Bentley Silver Cloud II models, and the large Rolls-Royce Phantom V chassis designed specially for extra-long limousine bodies.

Both Daimler and Rolls-Royce announced new V8 engines, the latter of all-aluminum construction having cylinder banks at 90 deg and being of large displacement (6230 cc or 380.2 cu in.). Two carburetors, wet cylinder liners, hydraulic valve lifters, and a comparatively low (8/1) compression ratio are used. The transmission and engine are of unit construction and, in view of the use of aluminum, inhibited glycol is required as the cooling fluid. A history of the development of this engine states that noise suppression has been something of a problem. It is further noteworthy that this is the first new engine announced by Rolls since 1923, when the last 6-cyl design was introduced; output of this 6-cyl engine having been increased $4\frac{1}{2}$ times in the intervening 36 years!

The 1959 London Show also saw the first instance of a genuine automatic transmission offered by a European producer on a high-volume car with an engine no larger than 1500 cc (91.5 cu in.). Rootes announced the availability of the Easidrive transmission on their Hillman Minx and Singer Gazelle cars as an optional extra.

Automatic transmission on Hillman and Singer

The basis of this transmission received considerable publicity in 1956 as the Smith Auto Selectric and has not changed materially since that date; however, it has topical interest meriting rather full description here.

The Smith transmission provides a 3-speed transmission with automatic gear changing and 2-pedal control (Fig. 4). Drive is purely mechanical in every ratio and mechanical efficiency is claimed to be better than that of a conventional friction clutch and synchromesh transmission.

The transmission consists, in effect, of two clutches on the engine flywheel; No. 1 coupled direct to the transmission output-shaft, and No. 2 coupled, also to the transmission output-shaft, but via a "2-speed and reverse" gearbox. (See Fig. 5A.)

Direct ratio is obtained by engaging No. 1 clutch, in which condition the 2-speed gearbox is out of action and no gears are either under load or idling. Mechanical losses are at a minimum. (See Fig. 5B.)

The reverse gear disregarded, the 2-speed transmission consists of a main-shaft and a lay-shaft, the lay-shaft driven by clutch No. 2 via a constant running pair. It provides two indirect ratios.

The driven gear of the higher (the lesser reduction) indirect (or intermediate) ratio couples to the output-shaft via a dog clutch.

The driven gear of the low (the greater reduction) indirect ratio couples to the output-shaft, via a free-wheel.

Thus, with intermediate ratio disengaged from the output-shaft, the low-speed ratio pair takes up the

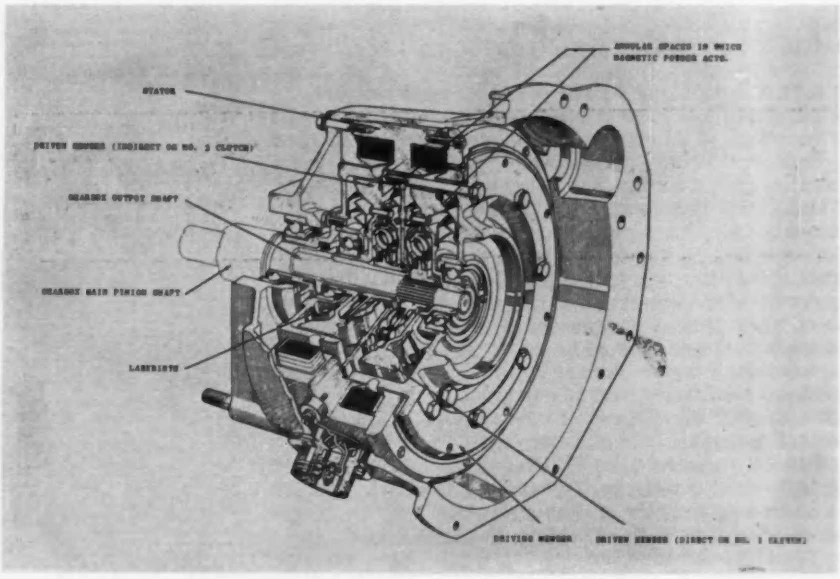


Fig. 6 — Magnetic clutches in Easidrive transmission.

drive to the output-shaft (Fig. 5C); and with intermediate ratio engaged to the output-shaft the low-speed ratio driven gear freewheels on the shaft (Fig. 5D).

The two clutches are "magnetic powder couplings." The connection between the driving and driven member of each clutch is fine magnetic powder in the small annular space between the driving and driven members. (See Fig. 6.) Normally, centrifugal force disperses the powder evenly over the bore of the driving member, clear of the driven member. When energized by a stationary field coil, the magnetic powder concentrates into columns of material bridging the annular space between the two members and transmitting the drive, by friction, from one to the other. (See Fig. 7.)

The clutches are engaged or disengaged by controlling the electric current passing through the two stationary field coils. Except for manual engagement of reverse, the complete control of the transmission is electrical. Engagement and disengagement of intermediate ratio from either direction are actuated by a solenoid; means of engine speed synchronization are provided as described below.

The only ratio change involving dog clutch engagement is from low to intermediate and for this a balk ring prevents premature engagement. When changing from low ratio to intermediate, synchronization is achieved by momentarily engaging No. 1 clutch, which acts as a brake to slow down the engine. When changing from direct to intermediate ratio the throttle is normally open and the engine gains speed spontaneously to the point of synchronization. A further solenoid device is, however, provided to increase throttle opening in the event of this change being made with the throttle closed.

The gearset is not fully synchromesh, but gear changing is assisted by balk rings (without synchro cones) interposed between the two engaging halves (the driving and the driven) of the dog clutch. Automatic changes are controlled by a governor, which is sensitive to both road speed and throttle opening. This sensitivity permits gradual buildup of torque at the driving wheels through variable generator output to the clutch field coils.

Electrical components of the transmission are:

1. Field coils — Normal drain is about eight amperes, but an economizer device reduces the demand during light drive and overrun.
2. Selector switch — Controlled by driver.
3. Gearshift solenoid — Operates dog clutch of the intermediate gear.
4. Throttle solenoid — Synchronizes engine speed during shift from direct to intermediate.
5. Governor — Sensitive to road speed and throttle opening; automatically selects gear ratio.
6. Control unit — Energizes appropriate electrical circuits according to input from governor and selector switches.

In the event of generator or other electrical failure, an emergency switch connects the car battery directly to the No. 2 field coil, permitting operation in either direct or low and reverse.

Pirelli BS3 tire

This novel tire has a flexible inflatable body on which are installed three annular sections of tire tread (Fig. 8). These are held in place by inflation of the tire body and also because of the fact that they are made of a harder material than the center portion of the tire and contain steel bands to prevent their stretching. Advantages claimed for the BS3 are chiefly in the sphere of replacement cost. If only one tread is damaged it can be replaced by itself, while all three tread rings are stated to cost only some 36% of the price of a new tire. In addition, cross-country, sand, snow, or other specialized treads may be used, as required, much more cheaply than if it were necessary to purchase complete tires. Published articles indicate that it does not seem possible to dislodge the treads by violent driving methods, while Pirelli says that this tire has demonstrated exceptional qualities of durability, sturdiness, road-holding, lightness of steering, and noiselessness.

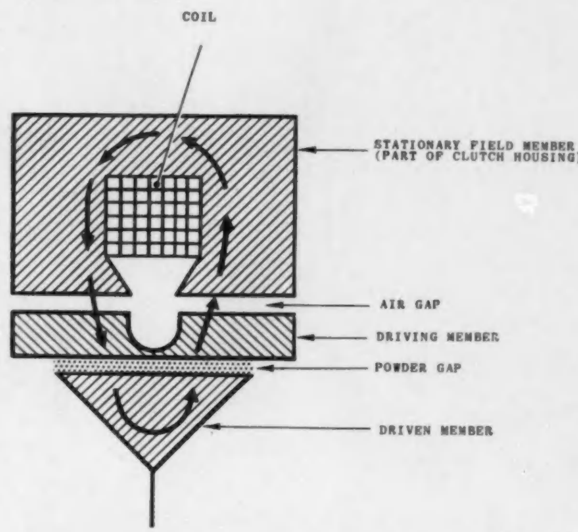


Fig. 7 — Diagram of magnetic clutch in Easidrive transmission.

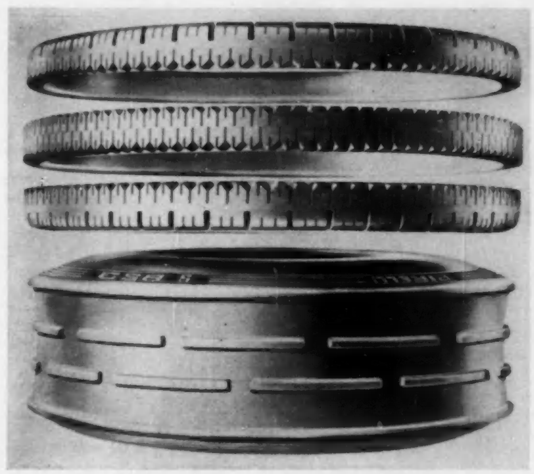
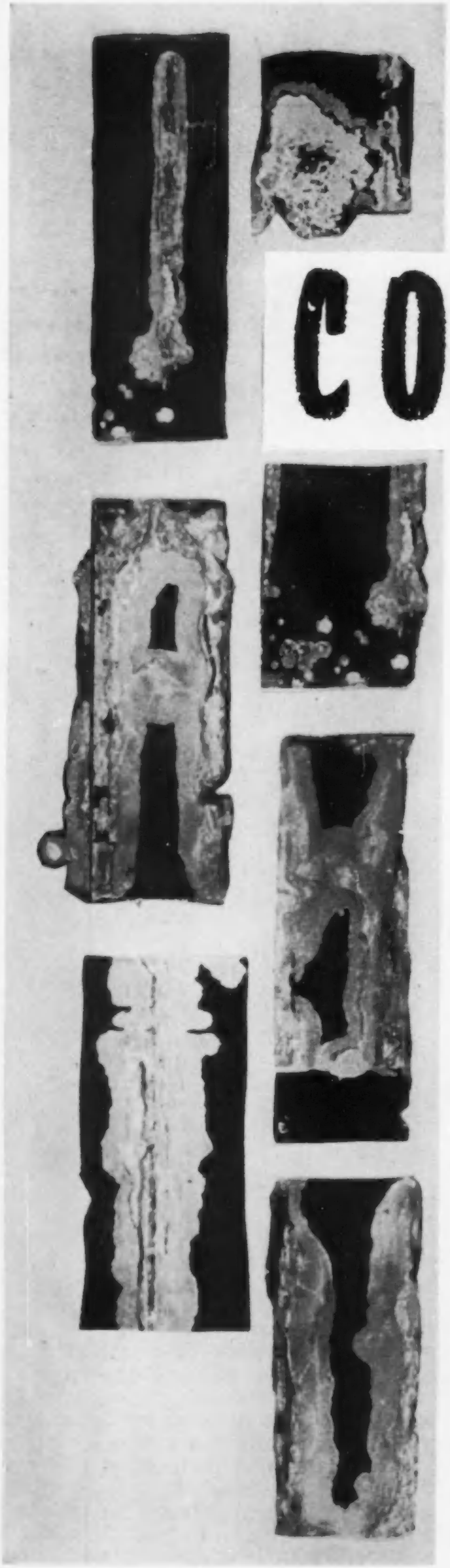


Fig. 8 — View of Pirelli BS3 tire with separate treads.



corrosion

INFORMATION about improvements in corrosion-prevention methods has recently been made available by engineers from American Motors, Ford, Chrysler, and General Motors. This article briefs this information. The ever-greater use of anti-icing materials on roads and streets keeps the anti-corrosion challenge strong, despite continuous, widespread research in recent years.

WIDESPREAD CORROSION prevention studies throughout the automotive industry have brought many recent changes in methods of protecting passenger cars . . . but nothing remotely resembling standardization of practices. And different producers emphasize different phases of their protection techniques as most significant.

American Motors practice

American Motors, with 20 years of service experience in preventing corrosion on unitized bodies, for example, provides for minimum drainage and for practically no ventilation (Fig. 1). The lower box section areas of Rambler bodies are protected by a coating which doesn't require a definite amount of ventilation to control corrosion.

American Motors engineers figure that minimum ventilation results in less dust and salt-laden water being inspirated into inside areas. Salt-laden mud, they point out, if allowed to build up would be slow-drying even with maximum ventilation . . . and would ultimately attack the inside surfaces.

The processes of preventive corrosion protection on Rambler unitized bodies begin with a deep primer dip, designed to provide a thorough coverage on all surfaces. This process involves lower labor costs than does the manual application of weld primer to the extensive inside surfaces. Also, it removes previous problems of obtaining a uniform coating.

Car makers emphasize different elements in new prevention practices

In preparing the body for the deep dip primer, most of the body components are washed prior to assembly. Since the solvents in the primer dip would attack and damage most sealers and sound deadening materials, these usually are not applied till after dipping. Those applied prior to dipping are of a special type which resist the solvents, and hot washing and phosphatizing solutions.

The front fenders and auxiliary components enter the body structure at this stage of the corrosion prevention treatment. Problem: to find a seam gasket material that would be resistant to the solvents and phosphatizing solutions and which wouldn't become hard and brittle during the prime bake at 375 F presented quite a problem.

After testing many different materials, ordinary asphalt impregnated roofing paper was found to be the most satisfactory for this application. A similar situation existed for a section filled with sponge rubber. This was solved by a vendor coming up with a neoprene sponge that didn't harden too much in the bake.

As many openings as possible are provided in the body to assure rapid filling and subsequent drainage of the primer during the dip operation. After this is done, the completed body assembly is washed in a high-volume, low-pressure, hot alkaline wash to flush out dirt and weld-splatter accumulated during assembly. This material, if not removed, would later contaminate the primer. This is followed by the phosphatizing, dry-off, primer dip, drain, and bake. The sealers and sound deadeners are then applied.

A solvent cut-back inhibited wax-type material is sprayed into the lower box sections by using a special spray nozzle on the end of a long probe which enters the sill area through a hole in the lower front wheelhouse and extends back through the sill to the rear kick-up. This material further enhances the protection of the epoxy-ester primer. (The primer is pigmented with iron oxide and zinc chromate.)

The many holes provided for rapid filling and draining of the dip primer are then sealed with rubber and plastic plugs.

The deep primer dip coating on all inside surfaces, reinforced with inhibited wax in the most critical areas, should provide adequate protection on the in-

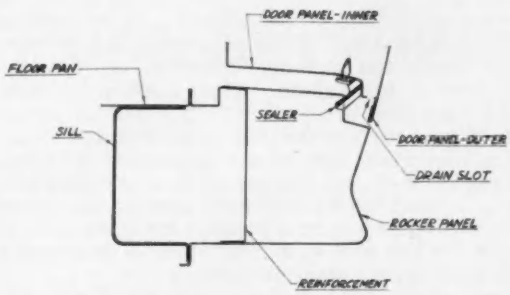


Fig. 1 — The 1960 Rambler inner door panel and rocker panel provide practically no ventilation and only minimum drainage . . . permitting less dust and salt-laden water into inside body areas.

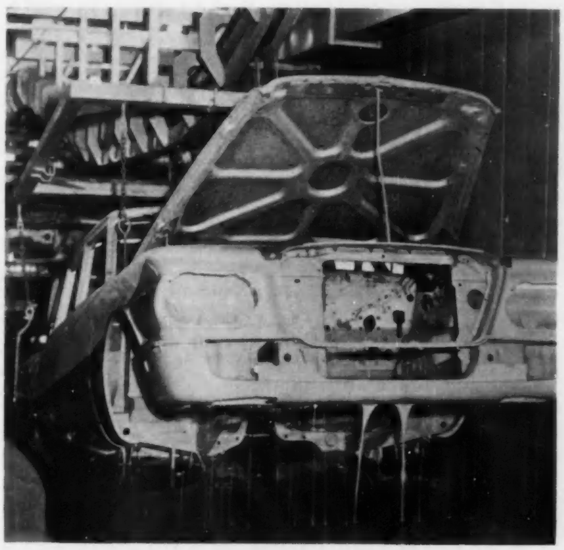


Fig. 2 — One step in underbody protection of Chrysler unitized bodies is to apply a water-reducible primer to the critical lower areas, as shown.

side. The deep primer dip coating under the fender wheelhouse areas is further reinforced with another spray-applied coat of the same material which is then baked. The underfender seams are heavily sprayed with a layer of asphaltic sealer. The whole wheelhouse-fender area is then sprayed with a heavy layer of asphaltic sound deadener. This should provide satisfactory protection from salt-laden moisture as well as gravel and dirt thrown off by the wheels.

Ford's Falcon newly treated

Use of differentially coated galvanized steel — made feasible by development of a new continuous hot-dip process — is a main item in the corrosion protection Ford engineers have designed into the Falcon.

In two-and-a-half years of research on how best to give unitized bodies corrosion protection, Ford engineers found that galvanized steel had the greatest life span of any protective material. But, they found also, that galvanized steel in its usual form was not adaptable to production-line welding and painting practices. Then, a process which would make galvanized steel use practical was developed and used in the Falcon. After passing through a hot-dip process, the steel is then wiped on one side to produce a surface that can be welded and painted.

The non-wiped side of the galvanized steel is arranged to cover the interior surface of boxed members. . . . The wiped surface is used as the exterior side of the part — and is painted for additional protection. Thus corrosion protection is provided for both interior and exterior surfaces.

Chrysler uses 6-stage treatment

A six-stage immersion and spray treatment is being used on the new unitized bodies of Chrysler Corp. cars, including the new Valiant. The entire raw body is cleaned and coated by this six-stage sequence. Then a new-type water-reducible primer is applied to the critical lower areas as shown in Fig. 2.

During the immersion and spray sequence, the body is first cleaned with an alkaline cleaner. Then, it is rinsed, coated with phosphate, rinsed again . . . and, finally, dried and cooled to room temperature.

The last step is to dip the entire underbody in the newly-developed primer.

After the coated body is dried, the exterior is sprayed with two base coats of an epoxy paint. Then, after wet sanding, two baked-on coats of enamel are applied.

The order of the various steps in this Chrysler corrosion protection process are detailed in Fig. 3.

Recent GM steel-surface studies

General Motors Research Laboratories have recently turned up some interesting findings about the effect of surface properties of steel itself on the corrosion properties of the metal after undergoing a phosphating process. (SAE Journal will detail these important findings in its March issue.)

The GM researchers found, among other things, that the steels most susceptible to corrosion are those with a higher lead content on the surface than the steels which showed good corrosion resistance. Also, they suspect, there may be some contaminants on the steel that can be removed easily by normal cleaning methods used in phosphating, if the steel is processed prior to box annealing.

GM results have been presented to the steel companies and a cooperative program established to determine the cause of the variations noted by the researchers.

Continued research widespread

In addition to the recently revealed information from American Motors, Ford, Chrysler, and General Motors sketched briefly here, thousands of man-hours of additional study are being put in throughout the automotive industry to better the methods of preventing corrosion on cars and trucks. There is every indication that more data will be exchanged in volume between engineers of the industry in the months ahead.

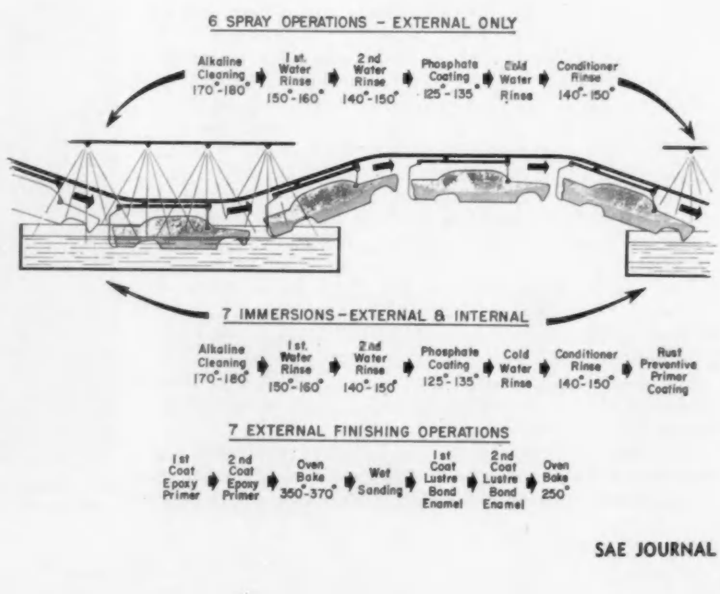


Fig. 3 — Body corrosion protection process used at Chrysler Corp.

New Extruding Techniques Developed for

High-Temperature Steel and Pure Beryllium

Based on paper by

Lyle M. Christensen

Norair Division, Northrop Corp.

NEW EXTRUSION TECHNIQUES for high-temperature steel and bare pure beryllium will meet the exacting requirements of future flight vehicles. These methods are being developed as part of two contracts awarded to Northrop by the Air Materiel Command Aeronautical Systems Center. One-half of the concurrent two-year programs has been completed.

Both materials are extruded in nearly the same temperature range, and both use glass as a lubricant. Each program is prefaced with and predicated on an airframe and extrusion industry survey, followed by a competitive development of the same shape by more than one extruder.

Steel Extrusion

A break-through in development of ultra-thin steel extrusion technique is close. Target requirements for Phase I of this program are a T-section — 1.50 by 1.50 in., with 0.062 in. thick legs. Fig. 1 shows the die.

The materials selected for extrusion development are SAE H11 grade (5% chromium hot work die steel) and A-286 temperature-resistant ferrous alloy.

Development participants are Allegheny Ludlum Steel Co., Harvey Aluminum and Comptoir Industriel d'Etirage et Profilage de Metaux, Paris. . . . Allegheny is believed to be the closest to solution of the problem at this time.

Allegheny has analyzed corrective procedures as follows: (1) proper container size must be established; (2) previous lubrication practices are inadequate, and CIEPM die lubrication techniques must be amplified; (3) die design and heated billet handling times are critical; and (4) more consistent temperature requirements, not only for the billet, but for various press components are necessary. Higher container heating is necessary.

The following new equipment was designed to obtain the needed thin-walled, close-tolerance shapes.

- Radiation shield — This was redesigned to give more complete protection against radiation and convection losses (Fig. 2). Efficiency of the shield was established by comparing cooling temperatures of a billet exposed to air after furnace heating. Figs. 3a and 3b show the test results, with temperature plotted against seconds.
- High heat container liner — The electrically-heated container was rewound on the outside to provide higher capacity heating coils. Also, a new liner with higher temperature materials was designed with another set of coils on the liner periphery. . . . This produces additional heating in the immediate proximity of the billet contacting surface.
- Billet lubrication — A special tool was designed and fabricated to inject lubricant on the billet while it is in the radiation shield as it is withdrawn from the salt bath. This permits keeping the billet inside the shield until it is ejected directly into the container.
- Dies — New die designs have been made to improve flow characteristics.
- Billets — A-286 billets have been capped with carbon steel to ease starting pressure.
- Loader — Existing loader was reworked to han-

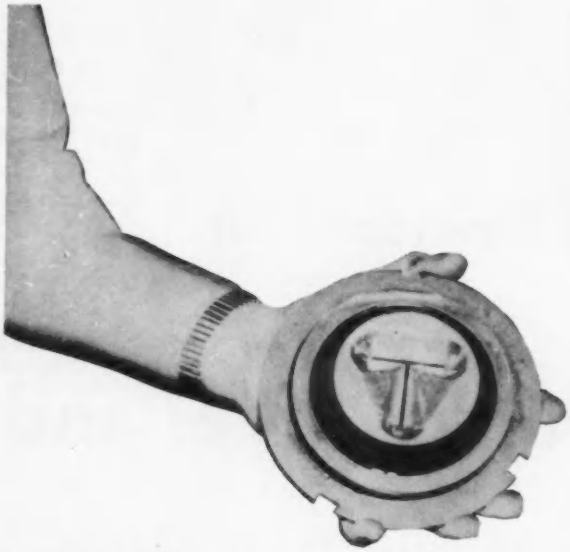


Fig. 1 — T-shape die for steel extrusion.

High-Temperature Steel and Pure Beryllium

. . . continued

dle the radiation shield with the billet inside, and to withdraw the shield after ejection of the billet into the liner.

- Die lubrication — New glass lubricant materials were compacted into contoured discs.

With the new equipment complete, extrusion of both A-286 and H11 was attempted, in order to perfect details of billet lubrication.

The first effort with the new liner was extruding A-286 at 2100 F to a thickness of 0.03 in. It was pushed successfully, with liner temperature at 1200 F. Then H11 was pushed at 2300 F and deteriorated. The temperature was lowered and the shape for H11 was excellent for 14 ft, but the die washed and severed the vertical leg. The liner cracked after the third push. These extruding tries indicated the following:

(1) A-286 can be extruded at 2100 F (salt bath temperature) to 0.093 in. thickness.

(2) Extrusion of H11 is better at 2250 F.

(3) A-286 should be extruded at 2050 F or lower.

(4) Use of nickel plating as a metallic lubricant warrants more investigation.

(5) Die design had to be altered to enlarge the fillet radii.

Another push was made with a reworked liner to study die glass, billet glass, and nickel-plate lubrication. The first H11 billet did not fill out because not enough dwell was allowed in the extruding cycle. The next H11 billet, with 0.04-in.-thick plating of nickel was extruded with an excellent 24-ft result. A third attempt was made to establish reliability of the nickel coating, but the push stalled the press. The stem bent badly and ruined the new liner.

The advent of the steel strike has forstalled any further attempts at extruding steel.

Bare Beryllium Extrusion

Extrusion of bare beryllium is feasible. . . . It has been sufficiently demonstrated to expect that future process refinements will make aircraft-quality extrusions available in popular sizes, shapes, and lengths in less than two years.

Material used for extrusion production development was QMV[1] (or equivalent) sintered pure beryllium powder billet made from 200-mesh powder. Cast beryllium and beryllium alloy products which are in various stages of development will be studied and evaluated as this program progresses.

The beryllium configuration is a great advancement in target tolerances, surface finish and extrusion length. Fig. 4 shows the channel-type section with 0.12-in.-thick segments.

Beryllium Corp. and Nuclear Metals, Inc. were chosen to participate in Phase I of the program.

Conventional oil hydraulic extrusion presses were employed in beryllium extrusion method developments. Beryllium, although it is a light metal, is extruded at high temperature by streamline flow.

Lethal fumes may be emitted by beryllium at extrusion temperatures. So the extruder has to protect his employees and the surrounding community from beryllium poisoning.

Die materials and design

The abrasive effect of beryllium on extrusion dies and the tendency of beryllium to fracture at intermittent intervals, or "rattlesnake," are perplexing problems in designing and selecting die materials. Cobalt-chromium alloy discs best withstood repeated extrusion of beryllium during development. They will probably be used until improvement in extrusion techniques, such as lubrication, makes the use of less expensive die blanks practical.

Lubrication

Beryllium extrusion lubricants must: (1) not react with or contaminate the beryllium being extruded, (2) wet and adhere to the billet surface, (3) possess body and lubricity, (4) insulate the die from the material being extruded, (5) become viscous at the proper temperature.

These requirements are more nearly fulfilled by glass than by any other lubricant yet tried.

Extrusion techniques

The beryllium billet is first heated to the desired temperature. Then it is removed from the furnace,

[1] QMV is a commercial designation for material produced by Brush Beryllium and indicates vacuum casting of beryllium pebbles.

rolled in glass powder, flock, or both, and placed in the container of the extrusion press. The ram is then brought forward, and the beryllium is extruded through the die.

In the development work, transfer was accomplished manually.

In addition to conventional extrusion sequences, beryllium can be more easily extruded if a soft copper-nickel alloy is placed in front of the billet to start the extrusion. After the nose material softens the lubricant, establishes a streamline flow pattern, and passes through the die, the beryllium follows through more readily than if the nose were not used.

Billet heating

The billets were heated in such a way as to prevent material contamination during the heating period. One way was to heat them in a 10% sodium chloride-90% barium chloride salt bath. Another method was to heat the billets in an argon-filled box placed inside an electric furnace. Argon was continuously fed into the inner box through a metal tube which passed through the furnace door. To further reduce chances of contamination, the billets were coated with a water-soluble glass slurry before being heated.

Billet transfer

Long billet transfer times cannot be tolerated, although the extrusion press container is maintained at about 900 F. Transfer times of less than 25 sec were usually found satisfactory.

Extrusion temperatures

Beryllium extrusion billet temperatures were approximately 1645–2000 F at time of removal from

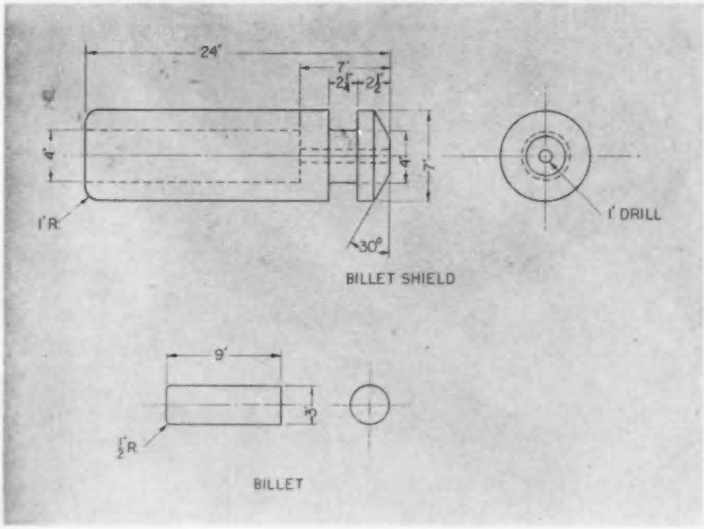


Fig. 2 — Radiation shield and billet.

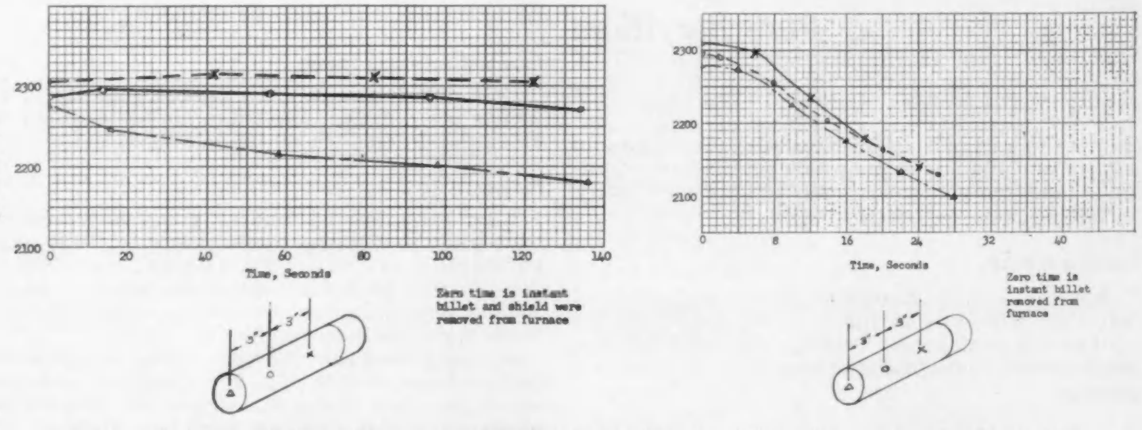


Fig. 3a — Steel billet cooling temperatures inside radiation shield. 3b — Billet cooling temperatures without shield.

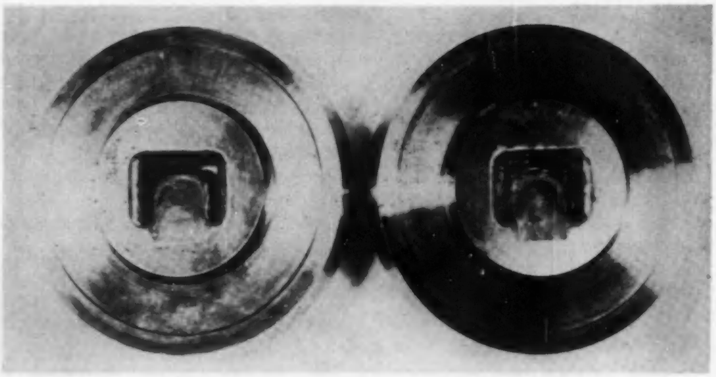


Fig. 4 — Channel-shape die for extruding beryllium.

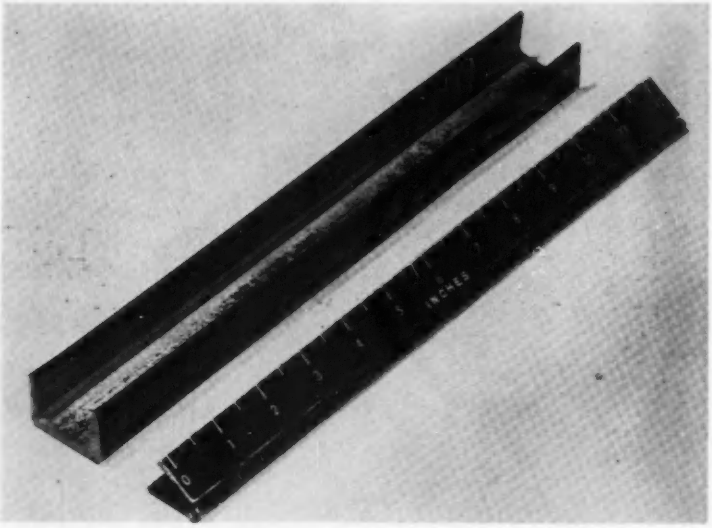


Fig. 5 — Defect-free bare beryllium extruded channel shape. Black patches on surface are glass lubricant particles which are easily removed.

High-Temperature Steel and Pure Beryllium

. . . continued

furnace or salt bath. Billet temperature at time of extrusion could not be definitely determined. Optimum billet temperature is believed to be 1750–1850 F at time of removal from salt bath.

Starting tonnage

Starting tonnage to extrude beryllium U-channel was 1438–1700 tons on the large press and 457–949 tons on the small press. Tonnage available on either press was adequate to extrude the U-channel in 20-ft lengths.

Reduction (extrusion) ratio

Extrusion ratios varied from approximately 25:1 to 60:1. Optimum ratio for the bare extrusion of beryllium is between 20:1 and 35:1, depending upon size, configuration, and length of extruded product.

Ram and Extrusion Speeds

Ram speeds varied from almost zero up to 126 inches per minute. Maximum speed at which the extrusion exited from the die was about 90 in./sec.

Progress

After a number of failures, many improvements were made, and extruded channels with quality comparable to that shown in Fig. 5 began to exit from the die. Continued refinement of extrusion processes, tooling, and lubrication resulted in capability to extrude U-channels several feet in length.

Six extrusions were recently made. . . . The first two used cast stellite dies, and the third, a stellite-faced die. Cast dies produced two 6-ft lengths free of cracking, and were not damaged. However, the stellite-faced die began to deform under the load and caused rattlesnaking of the extruded piece.

Table 1 — Mechanical Properties of Bare Extruded Beryllium.

Specimen Number	Direction Of Grain	Ultimate Tensile Strength, PSI	Yield Strength, (.05% Offset) PSI	Percent Elongation, Dial Gage	Percent Elongation, Strain Gage	Percent Reduction Of Area	Modulus of Elasticity, PSI x 10^6
1	Longitudinal	68,330	54,000	6.6	1.66	1.0	Not Measured
2 *	Longitudinal	45,200	45,200	0.144	Not Measured	0.55	42.2
3	Longitudinal	78,400	50,200	7.0	1.61	0.3	43.7
4 **	Long Transverse	No Data	Not Measured	Not Measured	Not Measured	Not Measured	Not Measured
5	Long Transverse	39,500	Not Measured	1.0	Not Measured	Not Measured	46.5
6	Long Transverse	40,600	Not Measured	1.0	Not Measured	Not Measured	Not Measured

* Longitudinal specimen fractured prematurely

** Specimen pulled out; no values obtained

The next three billets were designed to study the possibility of reducing the necessary force of the extrusion press by extruding at a high temperature.

These tests show that the present marginal lubrication must be improved. In this connection, the roll of copper-nickel also must be investigated. Further examination of one extrusion showed rattlesnaking where the copper-nickel film terminated on the land but continued in the web; when termination of this film also occurred on the web, the section again became sound since no differential lubrication existed to allow the web to extrude at a faster rate when glass only was present as a lubricating medium.

Next series of extrusions will investigate the following:

1. Is the copper-nickel lead-in cone necessary when stellite dies are used?

2. Can the pressure pattern be favorably altered by (a) utilizing a different temperature-glass combination for the extrusion, (2) heating in a salt pot furnace rather than in a resistance furnace, (c) reducing the time at temperature by induction heating?

3. Does a "butt-end" effect exist?

Test results

Although the average spread between yield and ultimate tensile strength in beryllium is considerable, beryllium is notoriously low in ductility insofar as per cent elongation is concerned. Beryllium seldom necks down in the fracture area; consequently reduction-of-area percentages are usually only a small fraction of one per cent. Both strength and ductility in the short transverse direction are reported to be very poor. Table 1 shows mechanical properties in the longitudinal direction. Target mechanical properties in this direction were:

Ultimate Tensile Strength, psi	60,000
Yield Strength (0.2% Offset), psi	35,000
Per Cent Elongation in 2-in.	10
Per Cent Reduction of Area	10

Future work

Continuation of the bare beryllium extrusion program includes:

A. Investigation of means to improve material ductility.

B. Investigation and determining the effectiveness of new lubricants including: Glass lead-in discs, metallic billet coatings, variation in glass compositions or families, mixture of glasses and metals, and metallic lead-in pieces.

C. Extrusion condition investigations including: Temperature, Reduction ratios, and Extrusion speed.

D. Die design and die materials.

E. Post-extrusion processing such as straightening and finishing.

F. Determination and evaluation of mechanical properties.

To Order Paper No. 98U . . .
. . . on which this article is based, turn to page 6.

Tips on using

Aluminum in High-Output, High-Speed Diesels

Based on paper by

R. F. Schaefer

Aluminum Co. of America

ALUMINUM diesel-engine parts should be designed to take advantage of the various foundry processes now available in order to produce the most economical part.

Years of designing with aluminum have made obvious certain details which are of extreme importance. These are:

1. Generous blending from heavy to thin sections.
2. Broad, flat, low ribs rather than narrow, round and high ribs, which are frequent causes of failure.
3. Stud boss diameters two times the stud diameter, and threaded depth two times stud diameter, with a minimum of one and one-half times stud diameter.
4. Bolt fastenings located in or near supporting wall sections to minimize eccentric loading.

Cylinder block design

The crank compartment of a cylinder block can be designed as a full or semi-permanent mold casting. A direct draw metal one-piece core can be used if the minimum draft requirement does not produce an exceptionally heavy bearing bridge section. Optimum metal distribution can be produced in the bearing bridge area with the use of shell, CO_2 or sand cores.

In the right-cylinder section (marked No. 1 in Fig. 1), a method is illustrated for carrying the stud loading down through the column or rib in the side wall, blending into the lower cylinder and bearing bridge area, and having the same area at the bottom as at the top.

In the left-cylinder section, two methods of carrying the firing load down through the columns from the top deck to the bearing bridge are illustrated. No. 2 shows a short stud in the top of the column. No. 3 shows a drilled hole the length of the column for a long necked down stud to be seated in the bearing bridge. The latter method will carry exceptionally heavy loads from the head to the bearing bridge.

Fig. 2 shows two design treatments of the main bearing bridge. In Type A, two through bolts tie the bearing cap to the sidewalls and make it an integral part. This assures a more uniform load distribution and utilization of maximum bearing capacity on highly loaded applications. The main bearing stud should be carried well up into the bridge by counterboring the threaded hole to obtain better stress distribution. The stud should be necked down so that the shank diameter is equal to the root diameter of the thread. Type B is a conventional treatment.

Valve seat insert design

Valve seat inserts of aluminum bronze, steel, or stellite have been used for both intake and exhaust valves ports in aluminum cylinder heads, and they are no problem. Inserts of 5⅜ in. OD have been installed successfully. Since the largest possible valves are generally used, together with a nozzle or precombustion hole opening, care should be taken to provide sufficient metal under the seat and at the bridges between valve port and nozzle hole.

The screw-type nozzle holder can be threaded close to its actual seating area and avoid high stresses at the nozzle hole in the combustion deck.

Aluminum for pistons

Two developments to improve ring land life of aluminum pistons are shown in Fig. 3. The piston on

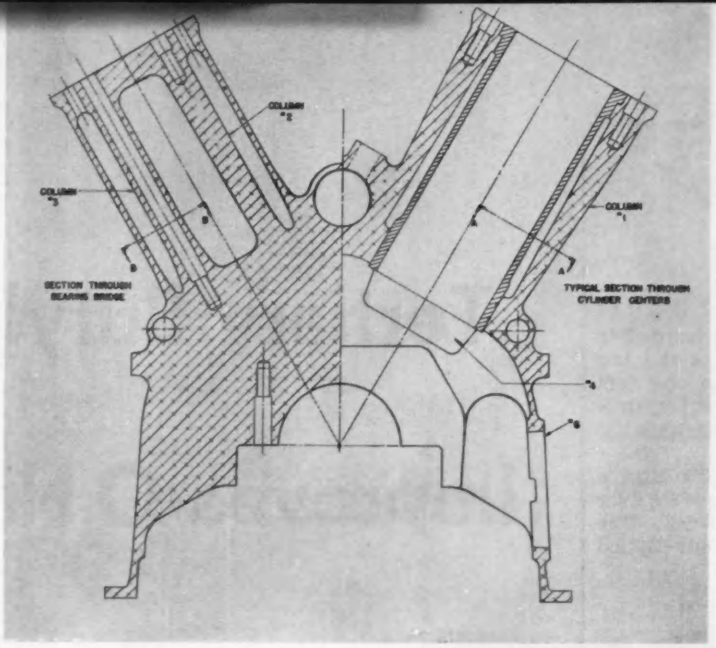


Fig. 1 — Transverse section of aluminum cylinder block showing (right) method of carrying stud loading down through the column in the side wall and, (left) two methods of carrying the firing load down through columns from the top deck to bearing bridge.

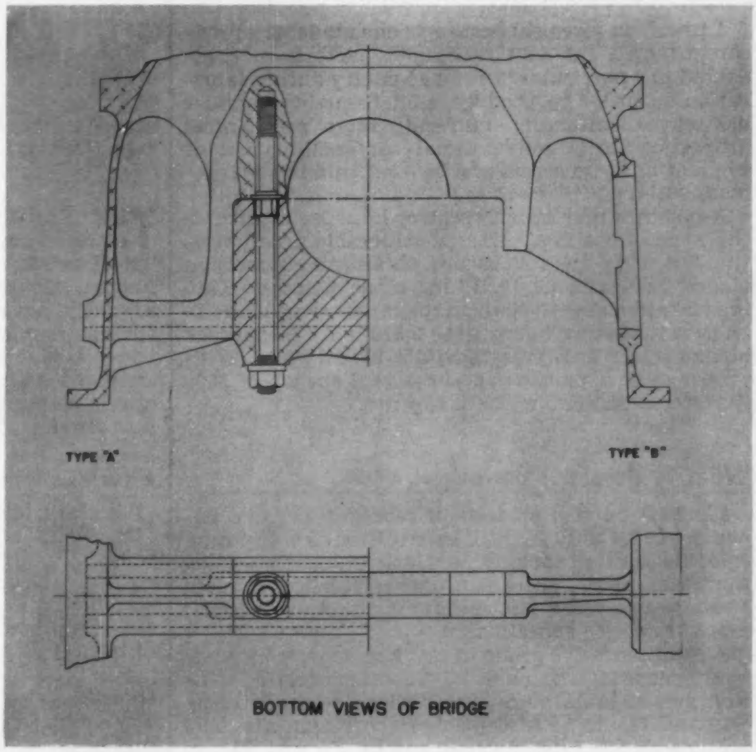


Fig. 2 — Two design treatments of the main bearing bridge in an aluminum engine. Type A assures uniform load distribution. Type B is conventional.

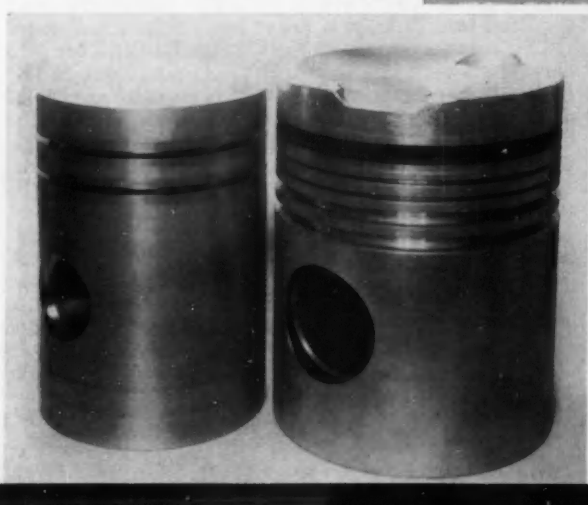


Fig. 3 — Two methods for improving ring land life of aluminum pistons. A ferrous ring groove insert is bonded to the aluminum in the piston on the right. Piston on the left has an aluminum alloy welded in the ring groove area and the grooves remachined.

Aluminum in High-Output, High-Speed Diesels

... continued

the right has a ferrous ring groove insert bonded to the aluminum. This successfully protects the top compression ring lands. The piston on the left shows a forging with a high wear-resistant aluminum alloy welded in the ring groove area and the groove remachined.

Tests indicate that a ring land of over 200 Bhn is obtainable with the hardness remaining well over 100 Bhn after 1000 hr at a temperature of 600 F. The alloy can be machined readily with carbide-tipped tools.

Value of premium strength castings

A premium strength casting is one made by a process in which the best techniques have been engineered to a particular casting geometry during fabrication in order to produce a high-quality product having exceptionally uniform, high mechanical properties. Any conventional- or combination of conventional-processes can be used, and heat-treatment will help.

A turbocharger air compressor impeller illustrates this type of casting. After considerable production, the following tolerances are obtainable: precision bladed part contour $\pm$ 0.015 in., blade spacing $\pm$ 0.010 in., radial blade $\pm$ 0.010 in., duplication from blade to blade and casting to casting $\pm$ 0.010 in. The average blade surface finish is well under 100 microin. With proper design, parts with peripheral speeds of 2500 fps have been spun without rupture.

What to do about corrosion

We have carried on tests of several types and exposures of up to 10 years of intermittent 3.5% sodium chloride solution spray at 30 C, continuous 20% solution spray at 20 C, and alternate immersion at room temperature. The last test most closely represents extreme service conditions.

A representative group of test bars exposed 6 years to alternate immersion in 3.5% sodium chloride solution showed aluminum-copper alloys, represented by 112 and 195, to be susceptible to corrosion, the aluminum-silicon type, represented by 355 and 356, to be excellent, with 356 the better of the two, and aluminum-magnesium alloys, represented by 214 and 220, to be the best of the lot. Examination of the 6-year specimens revealed every alloy in the alternate immersion test exhibiting a self-stopping type of corrosion. The performance of less resisting alloys can be improved by anodic coatings.

When inhibitors are essential to reduce rusting and scaling of iron parts, the addition of 1% of naphthenic-base soluble oil will do the job without serious galvanic attack of the aluminum.

To Order Paper No. 120U . . .
. . . on which this article is based, turn to page 6.

Tertiary Butyl Improves O.N.

Based on paper by

S. R. Newman, K. L. Dille, R. Y. Heisler, and M. F. Fontaine

Texaco, Inc.

THE SEARCH for additives that would increase the octane number of gasoline has led to the unearthing of but few additives showing commercial possibilities. Of these, an organic compound called tertiary butyl acetate appears to have the most promise for commercial application. It is called a "lead appreciator" because it is effective *only* in the presence of lead. Apparently, it increases or "appreciates" the antiknock characteristics of tetraethyl lead itself.

How much improvement

Tertiary butyl acetate — or TLA, as it is called (standing for Texaco Lead Appreciator) — gives significant improvements in the Research, Motor, and road octane numbers of leaded, high-octane, commercial-type motor gasolines. The magnitude of these improvements depends strongly on the amount of tel and TLA used in the fuel.

For fuels leaded to 3 ml per gal, peak octane responses occurred when 0.7–0.9% (vol.) TLA was used. The addition of more lead and more TLA produced higher peak octane responses. The use of less lead required less TLA for a lower peak octane response.

The octane improvement obtained with TLA also correlated with the Research octane number of the fuel. Higher Research O.N. responses were generally obtained with higher Research O.N. fuels. In certain of the high-octane fuels, Motor O.N. responses also increased with increasing Research O.N. of the fuels. Average Research and Motor O.N. response data obtained on commercial fuels were: 1.6 Research and 1.6 Motor O.N. for superpremium fuels, and 0.8 Research and 0.8 Motor O.N. for premium-grade fuels.

Response data on a large number of fuels indicated that different fuels responded differently to TLA. The reasons for these differences are now under

Acetate of Leaded Fuel

investigation. The laboratory octane responses were also verified on the road. The magnitude of these road responses depended on the rating characteristics of the particular car as well as on the particular fuel rated.

Typical test results

Fig. 1 shows typical response curves over the concentration range of greatest interest for two fuels of superpremium quality. Note that peak octane response for both Research and Motor octane numbers occurred in the region of 0.7–0.9% (vol.).

The road octane curves of Fig. 1 show the average modified borderline road octane-number improvement taken over the speed range of a 1957 car equipped with a 12/1 compression ratio engine. In this car TLA was equally effective at low and high engine speeds. Although the peak road octane response appears to occur in the region of 0.5–0.7% (vol.), the data shown for these fuels indicate a nearly constant response between 0.5 and 0.9% (vol.) TLA. This, of course, would be expected since it is extremely difficult to distinguish small road octane differences in fuels.

The effect of varying both TLA and tel concentration on peak octane response is shown in Fig. 2. The data presented are averages of Research and Motor O.N. increases in a superpremium fuel. These data indicate that an optimum ratio of TLA to tel exists. As the lead level was increased, both the quantity of TLA required for peak octane improvement and the magnitude of the improvement increased. At the 3 ml tel per gal level (101.6 Research O.N., 93.4 Motor O.N.) a peak octane response of 1.3 octane numbers was obtained with 0.8% (vol.) TLA. By adding 4 ml tel per gal to this superpremium fuel, 1.1% (vol.) TLA was needed to obtain a peak octane response of 1.9 octane numbers. A similar trend was also observed with a 105 Research O.N. fuel.

To Order Paper No. 127U . . .
. . . on which this article is based, turn to page 6.

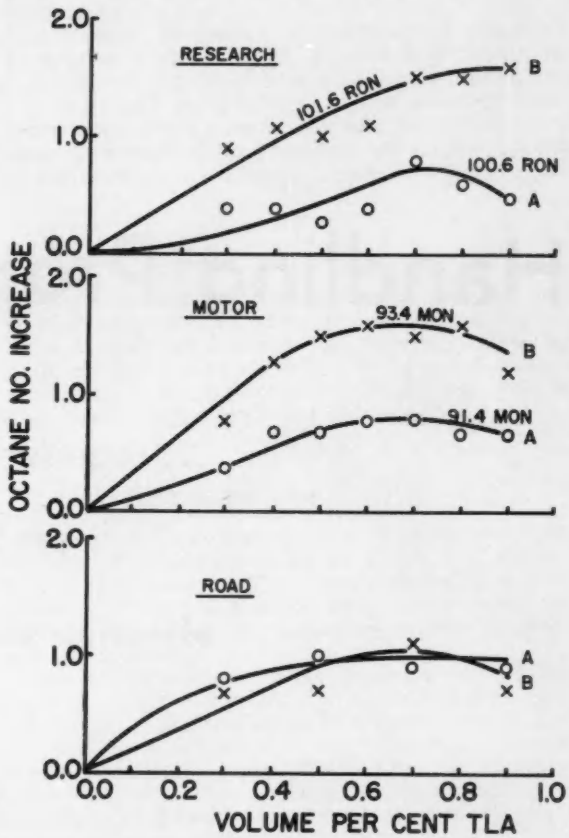


Fig. 1 — Effect of TLA concentration on octane response for superpremium-type fuels containing 3 ml tel per gal.

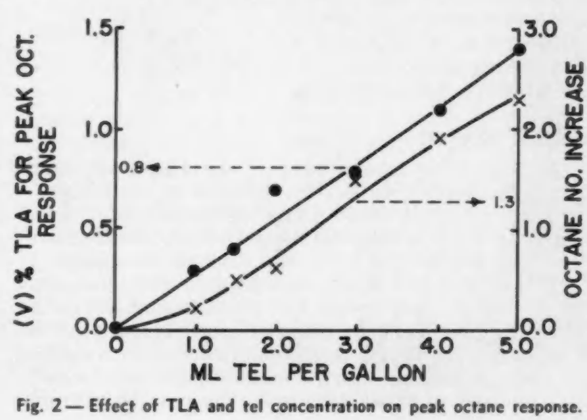


Fig. 2 — Effect of TLA and tel concentration on peak octane response.

Handling Propellants Safely

... requires special methods adapted to the problems peculiar to each type; and effective training of ALL personnel involved.

Based on report by panel secretary

L. D. Weber

Rocketdyne, North American Aviation, Inc.

THERE'S A WAY to handle safely every one of the various propellants used in missiles. But each has its special problems; each requires handling tailored to its particular difficulties. Important among the special problems to be met are toxicity, odor, corrosivity, inflammability, and sensitivity to mechanical or thermal shock. To insure safe manufacturing operations, process specifications must be established, and personnel trained.

Liquid oxygen

In handling **liquid oxygen,** for example, most manufacturers consider the concept of cleanliness a critical problem area. The definition of "clean" tends to differ widely among suppliers, shop personnel, and the user of the component or assembly.

It isn't always feasible to wait until final assembly at the test stand to do the proper cleaning. And even if a part has been cleaned properly, contamination can occur if it is poorly packaged or mishandled in transportation. Such contamination can be serious enough to cause failure of the part in ultimate use.

Hydrazine

Cleaning procedures satisfactory for liquid oxygen are thought to be satisfactory also for **hydrazine** systems and components as well. But the potential contaminants for hydrazine are different.

Hydrazine systems must be absolutely free of rust and other oxidizing elements; oxygen systems must be free of hydrocarbons and other combustible materials.

The materials from which parts are fabricated may also be different for hydrazine and for liquid oxygen systems. Aiming to select materials which will have no effect on the propellant:

- Most stainless steels are found suitable for use with hydrazine systems — but not iron, because rust might form. Also unsuitable are brass, copper, and alloys containing significantly large quantities of molybdenum . . . because they might catalyze the decomposition of hydrazine.
- Certain hydrazine derivatives (such as dimethylhydrazine) can be handled without difficulty in carbon steel systems.

In any case, selection of materials depends on the time and temperature of exposure . . . and whether the propellant is to be reused after passing through the system under consideration.

Liquid hydrogen

For **liquid hydrogen,** also, the same cleaning methods as for liquid oxygen are satisfactory . . . but, here again, the potential contaminants are different.

With liquid hydrogen, for example, there need be no concern for the combustibility of potential contaminants. The problem is to be sure the contami-

nant does not freeze at the extremely low temperature of the propellant. If it does, it may plug up small passages. Moreover, the liquid hydrogen system must be kept at a slightly-above-atmospheric pressure to prevent introduction of air or oxygen through a leak. Either air or oxygen will freeze at liquid hydrogen temperatures — and an explosive mixture might form.

One major concern in handling liquid hydrogen is the possibility of a person being burned severely before he recognizes that a fire exists. Hydrogen gas — which might escape from a leaking assembly — is very explosive and burns with a non-luminous flame. Besides, there is no radiation sideways from a hydrogen-air flame. Consequently, there is frequently no heat indication around such a flame to give warning of its presence.

Because of liquid hydrogen's extremely low temperatures, all-welded construction is preferable to gasketed joints. The all-welded construction prevents leaks from forming when the metal contracts thermally.

All piping in liquid hydrogen systems must be insulated by vacuum jacketing to prevent heat-leakage into the system. The propellant has such a low latent heat of evaporation that a small quantity of heat absorbed will vaporize a very large quantity of the liquid. With low-efficiency insulated lines, liquid air is frequently observed to be dripping off exterior surfaces.

Liquid fluorine

Liquid fluorine applications have to be concerned especially with toxicity and vigorous chemical activity. Though fluorine can be handled safely for long periods with many common metals, violent failure can occur if the system is not properly prepared. (Fluorine has a boiling point between those of liquid nitrogen and oxygen.)

So, cleaning requirements for liquid fluorine are much more stringent than for any other propellant in use today. Aluminum, copper, and stainless steels can usually be made "passive" to liquid fluorine. But the presence of even a minute quantity of contaminant can start a chemical reaction which will release heat. This in turn can cause ignition and combustion of the metal system.

After assembly, the entire liquid fluorine system must be "passivated" . . . by passing gaseous fluorine through the system—slowly at first and then at increasing rates. During this procedure, any small quantity of contaminant will be burned out under safe, controlled conditions. The gas also will cause a protective fluoride coating to be formed on the internal surfaces of the system. This helps to deter subsequent corrosion.

Nitrogen tetroxide

In handling **nitrogen tetroxide,** a major problem is to keep it dry. It boils at about 70 F and is a toxic gas. In the presence of moisture, very corrosive nitric acid is formed.

Normally, carbon steel components and assemblies are used with nitrogen tetroxide. But where there is potential exposure to atmospheric moisture, stainless steel is used. Storage tanks must be covered with an external reflective coating to minimize heating by the sun.

Interstate Commerce Commission regulations, governing transportation of nitrogen tetroxide, make the shipper responsible for proper packaging . . . to protect the public. (In new cases, supplier recommendations usually are accepted by the ICC until its laboratory and advisory group, the Bureau of Explosives, makes its recommendation.)

Solid propellants

Solid propellants are rather easily handled and shipped in accordance with procedures and regulations already established for high explosives by military agencies and by the ICC. Loaded rockets are transported in a non-propulsive state in order to maintain a high degree of safety.

Personnel training essential

Properly trained personnel is, of course, a necessity for the safe handling of all of the various missile propellants. The personnel training program established at Convair-Astronautics is typical of the importance given to training aspects throughout the industry.

The Convair-Astronautics program was established by a cooperative effort of all departments concerned. It consists of lectures, demonstrations, and written examinations. Detailed operating procedures are written cooperatively by the participating organizations. Thus, appropriate information is circulated to all personnel. Each participant gets a better understanding of his own functions . . . and of their effect on subsequent operations. The training program has developed among the personnel a sense of respect for the propellants, rather than fear or complacency.

The cleanliness concept gets emphasis in personnel training programs throughout the industry. The specific cleanliness needs are detailed as regards the handling of each of the different propellants. In connection with handling fluorine, where very careful safety practices are required, for example, emphasis is placed on the complete safety clothing required and on the breathing equipment with a self-contained air supply that the product's toxicity makes necessary.

Serving on the panel which developed the information in this article, in addition to the secretary, were: **W. J. Cecka, Jr.,** Rocketdyne, North American Aviation, chairman; **D. M. Tenenbaum,** Aerojet-General, co-chairman; **B. E. Hill,** Olin-Mathieson Corp.; **E. L. McCandless,** Linde Co.; **T. J. McGonigle,** Allied Chemical & Dye Corp.; **E. T. Higgins,** Rocketdyne, North American Aviation; and **C. W. Foster,** Convair-Astronautics.

(This article is based on a report of one of 16 production panels on missiles and aircraft subjects. All 16 reports are available as a package as SP-329. See order blank on p. 6.)

Brake Fade Rated by

Excerpts from paper by

Paul C. Hykes and Clarence A. Herman
Automotive Division, Budd Co.

BRAKE fade or loss of effectiveness occurs when heat is generated at a faster rate than it can be dissipated. The problem of properly describing fade resistance, therefore, is one of semantics.

Budd describes fade resistance in terms of continuous or steady-state horsepower. This decision was based on the fact that all automotive engineers know the term "horsepower" as used to describe engine power, and also know that the brake capacity required must be in a certain ratio with the power available in the vehicle engine. The brakes should not be expected to carry the vehicle down a grade or to stop it from a speed which is beyond the capabilities of the vehicle engine. The words "steady-state" or "continuous" separate the problem of heat storage from that of heat dissipation. Under steady-state conditions, heat is dissipated at the same rate that it is generated; and a brake, operating at its peak capacity under steady-state conditions, will theoretically operate indefinitely — the only type of failure possible being due to accelerated brake lining wear.

The adoption of our added descriptive term for brake fade resistance gave a means of comparing brakes without reference to size or type. We could pinpoint advantages of different designs of drums and of different drum materials. Evaluation of brake linings became more simple.

New term needed

The need for the new term becomes more obvious when we find that the Federal Government, in submitting invitations to bid on new military vehicles, gives braking requirements in such terms as, "Brakes must be capable of stopping the unit on a 30% grade from 40 mph without fade" and, "Vehicle must be able to stop in 128 ft from 40 mph consistently. The wording used is certainly ambiguous and could be most misleading.

In 1956 the Commonwealth of Pennsylvania, noting that certain accidents were being caused by vehicles which were either underbraked or overloaded, passed an ordinance that required all vehicles to have at least one square inch of brake lining for each 55 lb of gross vehicle weight. The Automobile Manufacturers Association and the Truck-Trailer Manufacturers Association viewed this activity with alarm, since it was a step toward design by legislation which in the long run would stifle engineering advances. Accordingly, the problem faced by Pennsylvania, and obviously other States, in promoting highway safety through legislation was referred to the Joint AMA-TTMA Committee on Vehicle Brakes. The Committee was asked to develop a method whereby the brakes on commercial vehicles could be realistically rated and certified by the manufacturer as to capacity.

The Budd test method and rating system was presented to the AMA-TTMA Brake Committee for consideration. With minor revisions this method is now undergoing tests, and results to date look promising. Meanwhile, the SAE Brake Committee is reviewing the overall problem, and it appears reasonable to assume that in the near future a new term will be added to our brake engineering vocabulary.

Peak and average braking power

Before we get into the problems of designing brake drums, let us first study some of the conditions under which the brakes and drums convert energy into heat. Since most fleet operators are familiar with the drum for the popular $16\frac{1}{2} \times 7$-in. over-the-highway truck and trailer brake, it might be best to concentrate on that size. The drum is used on vehicles having a legal weight limit of 18,000 lb per axle and many of the vehicles are capable of speeds of 70 mph.

In stopping such a vehicle from 70 mph, one

Engineering Yardstick

brake will absorb the energy of 9000 lb. This energy is simple to calculate:

$$KE = \tfrac{1}{2}MV^2 = \frac{WV^2}{2g} = 1{,}470{,}000 \text{ ft-lb}$$

where:

KE = Kinetic energy
M = Mass
V = Velocity, fps
W = Weight, lb
g = Acceleration due to gravity = 32.2 ft/sec^2

Since one Btu is equivalent to 778 ft-lb, the total heat generated in one stop is:

$$Q_T = 1895 \text{ Btu}$$

If the stop were made according to the Uniform Vehicle Code requirements of braking force equal to 43.5% of gross weight, the stopping rate is 0.435×32.2 ft/sec^2 = 14 ft/sec^2, and the actual stopping time would be 7.33 sec.

Thus, the 1895 Btu total heat generated in the stop would be absorbed in 7.33 sec. This equals 258 Btu sec and since 1 hp = 0.707 Btu/sec, the average horsepower in the stop is 365 hp.

This is the average horsepower developed during the complete stop. At the beginning of the stop, the peak horsepower is twice the average power, since the instantaneous power varies directly with the speed, and thus drops off to zero as the speed reaches zero.

Another way of figuring the peak power (the instantaneous power at the beginning of the stop) is from the braking force and speed. In our stop the peak power is: Power = $FV/375$ = 730 hp, where F = force (lb) and V = velocity (mph).

Fortunately, a truck or trailer combination is never called upon to develop braking power continuously at these high-power rates because:

1. On level roads, more than 730 hp per brake would be required to keep the speed at 70 mph.

2. In descending grades, the brakes are usually snubbed, and the average power is the same as if

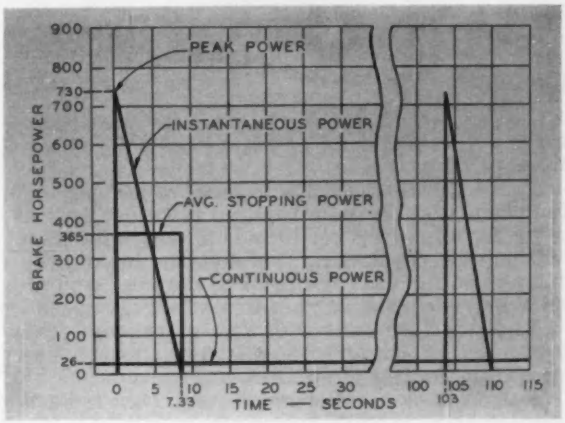


Fig. 1 — Braking power.

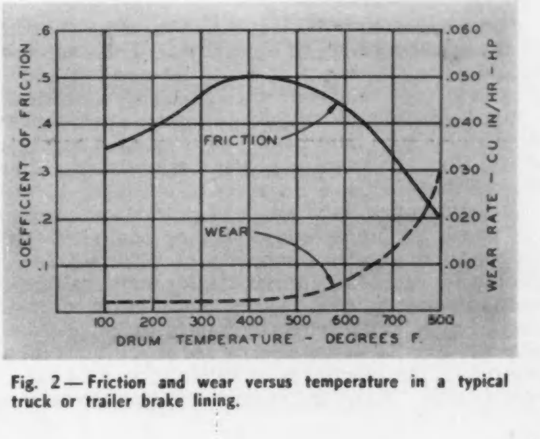


Fig. 2 — Friction and wear versus temperature in a typical truck or trailer brake lining.

Brake Fade Rated by Engineering Yardstick

. . . continued

the brakes had been applied continuously. To develop this continuous peak at 70 mph with dragging brakes would require a grade angle the sine of which is 0.435. This is an angle of 25¾ deg or a grade of 48.3%. Such a grade is out of the question on public highways and even if there were such a grade, it would probably be too short to have the power at the peak level very long and most likely it would be extremely unsafe to descend at 70 mph.

3. The power as calculated and shown is the total power exerted in stopping the vehicle; however, the brake does not convert all this power into heat. It is helped by wind resistance, tire rolling resistance, and friction in the rotating parts of the wheels and drive system components — all of which are otherwise known as parasitic power losses when referred to in their effect on reducing engine driving power. Engine braking also helps retard the vehicle.

Continuous power

Let's proceed to continuous power by again studying the vehicle making repeated stops on level roads from 70 mph.

Such a vehicle should be capable of making more than one stop per mile from 70 mph, but let's assume that one stop per mile is all that the engine will permit. In making the stop, the brake drums will absorb the heat and prior to the next stop, this heat must be dissipated. At an average speed of 35 mph there would be 103 sec for the heat to be dissipated. Therefore, the 1895 Btu should be dissipated at the rate of 18.5 Btu/sec.

We now have a power requirement which we can convert into continuous horsepower (chp); thus 18.5 Btu/sec = 26 chp.

So far we have given no consideration to the parasitic losses such as rolling resistance, engine drag, or wind resistance; and when the 26 chp is compared to the actual capacity of brakes, as tested on a dynamometer, it is found to be at least 30% high.

Budd has found by extensive testing that the steady-state capacity of a brake and drum assembly should be in the range of 1.2 to 1.3 chp per 1,000 lb brake load for relatively safe highway operation.

Fig. 1 graphically shows the instantaneous power during the stop, the peak power at the beginning of the stop, the average power during the stop, and the continuous power in a series of stops.

The difference between peak-power and continuous power of brake drums can be compared quite simply to the storage capacity of a funnel and its discharge rate. A funnel could have gallons of storage capacity and gallons per minute as a discharge rate. This would compare to Btu's storage capacity and Btu's per minute (or continuous horsepower) as the discharge or dissipation rate for the brake drum. As in the funnel, the two characteristics, storage capacity and discharge rate are entirely divorced from each other.

Grade prediction

So far, we have analyzed fade resistance from the standpoint of high-speed stops only. This is only a portion of the problem, since a series of snubs from lower speeds can also build up destructive temperatures. Long mountain grades also must be considered. However, with our new term "continuous horsepower," we can predict the grade that a vehicle may safely negotiate. The formula is:

$$\text{Grade} \times \frac{\text{chp} \times 375}{\text{gvw} \times \text{speed}},$$ where grade is expressed in per cent, chp is continous horsepower capacity of the vehicle brakes, and speed is in miles per hour.

For actual application of this formula, the rolling resistance, wind resistance, chassis friction, and engine drag must be added to the chp of the brakes.

Table 1 shows data based on the SAE Truck-Ability Prediction SP-82. The effect of brakes has been added on the basis of 1.3 hp/1000 lb gvw. This figure is, as pointed out earlier, one which appears possible. Note that these calculations cover grades of indefinite length; therefore, true steady-state conditions must obtain.

Heat storage capacity depends on temperature, weight

We have shown that one of the requirements of a brake drum is that it be able to absorb heat at its peak power to temporarily store it and to dissipate it later at its continuous power capacity. This heat can be stored in a certain brake drum at a certain temperature and the same amount of heat can be stored at a higher temperature in a lighter drum or at a lower temperature in a heavier drum. The problem then is a compromise between drum weight and temperature. The drum weight necessary to store the 1,895 Btu developed in one stop can be determined from the formula:

$$W = \frac{Q_s}{C_p\,(T_2 - T_1)}$$

Where:

W = Weight of drum, lb

Q_s = Quantity of heat stored, Btu

C_p = Specific heat of drum material, Btu/lb/F (0.12 for cast iron)

T_1 = Initial temperature of drum, F

T_2 = Final temperature of drum, F

As an example, if 200 F is a safe average drum operating temperature, W = 121 lb.

Similarly, if a safe average drum temperature is 300 F a drum weight of 69 lb will suffice.

However, if a vehicle is able to make stops from higher speeds than 70 mph, or if it is called upon to descend grades at higher speeds, for short durations, the thermal storage capacity of the drums

Table 1 — Parasitic Versus Brake Horsepower Required For Various Vehicles On Grades

CONDITIONS :- 3500 R.P.M. ENGINE SPEED
FRONTAL AREA — 75.00 FT.^{2} FOR 20,000 TO 50,000 G.V.W.
50.83 FT.^{2} FOR 10,000 G.V.W.
39.00 FT.^{2} FOR 5,000 G.V.W.

G.V.W. LBS.	VEHICLE VELOCITY M.P.H.	PARASITIC HORSEPOWER DUE TO :-				TOTAL BRAKE H.P.	PERCENT GRADE REQUIRED TO MAINTAIN SPEED	PERCENT GRADE PERMITTED WITH BRAKES
		ROLLING RESISTANCE	AIR RESISTANCE	CHASSIS FRICTION	TOTAL PARASITIC			
5,000	20	2.51	1.78	4.50	8,79	8.5	3.30	5.73
	30	4.12	6.07	4.50	14.69	6.5	3.67	5.30
	40	5.98	14.28	4.50	24.76	6.5	4.64	5.86
10.000	20	5.01	2.33	8.00	15.34	13.0	2.88	3.44
	30	8.24	7.92	8.00	24.16	13.0	3.02	4.65
	40	11.95	18.62	8.00	38.57	13.0	3.62	4.83
20,000	20	10.02	3.59	15.05	28.66	26.0	2.69	5.12
	30	16.48	12.20	15.05	43.73	26.0	2.73	4.36
	40	23.90	28.71	15.05	67.66	26.0	3.17	4.39
30,000	20	15.03	3.59	22.00	40.62	39.0	2.54	4.98
	30	24.72	12.20	22.00	58.92	39.0	2.46	4.08
	40	35.85	28.71	22.00	86.56	39.0	2.71	3.92
40,000	20	20.04	3.59	29.05	52.68	52.0	2.47	4.91
	30	32.96	12.20	29.05	74.21	52.0	2.32	3.94
	40	47.80	28.71	29.05	105.56	52.0	2.47	3.69
50,000	20	25.05	3.59	36.00	64.64	65.0	2.42	4.86
	30	41.20	12.20	36.00	89.40	65.0	2.24	3.86
	40	59.75	28.71	36.00	124.46	65.0	2.33	3.55

NOTE :- COMPUTATIONS BASED ON S.A.E. TRUCK ABILITY PREDICTION SP-82 FOR PARASITIC H.P.

should be increased by additional weight to take care of the higher peak power demands.

Heat disposal

Brake assembly heat can be disposed of as follows:

1. Radiated to surrounding parts. This is undesirable . . . tires build up temperatures on their own account.

2. Conducted to surrounding parts. This also is undesirable . . . the closest parts, such as the tire, the hub, and its bearings should not be overheated.

3. Convected into the passing air. Here is the place for the heat! While heat is dissipated by convection mostly from the drum ring, it also is convected from the surrounding parts which have been heated by radiation and conduction.

Calculations show that conduction and radiation are but minor factors in dissipating heat from the brake drum. Use the example of a standard $16\frac{1}{2} \times 7$-in. drum braking a 9000-lb load to a stop from 70 mph, and assume that the drum ring has an exterior surface area of 3 sq ft. If the surface area is at 300 F and the ambient temperature of air and surrounding parts is 70 F, then it would require more than $1\frac{1}{2}$ hr to radiate the 1895 Btu if the drum surface temperature stayed at 300 F. But since its temperature drops as it loses heat, it would require more than 3 hr to radiate it all.

Making appropriate assumptions for conduction paths, it would take 49 minutes to conduct away the heat of one stop. But the actual time would be more than twice as long since the drum temperature would drop off while the wheel temperature would start at 70 F and increase, thereby decreasing the differential.

Thus, convection is the only method left to dispose of the heat fast enough for the brake to perform satisfactorily.

Brake drum design and materials

The usual goals in designing current automotive products are maximum performance, long life, light weight, and low cost achieved through economy of manufacture and low material cost. At the Budd Company, the additional and more specific objective for brake drum design is to have it function at as low a temperature as possible. There are several reasons for this approach:

1. Contemporary brake blocks are predominately of the organic type and their friction characteristics vary appreciably with changes in temperature. With small increases in temperature, up to about

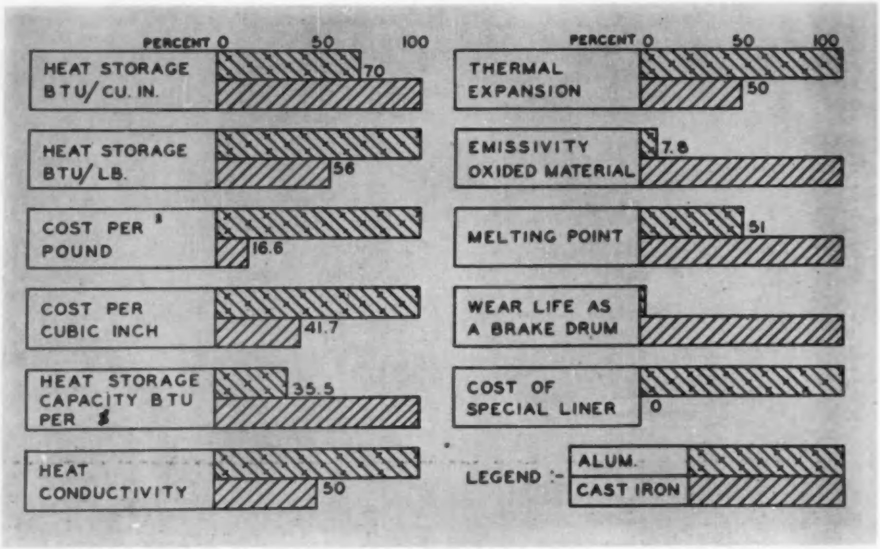


Fig. 3 — Comparison of cast aluminum and cast iron as brake drum material.

Brake Fade Rated by Engineering Yardstick

. . . continued

400 or 500 F, the coefficient of friction drops off but slightly; in fact, in many linings it increases a little. At higher temperatures, the coefficient of friction drops off considerably, often going to half of its normal amount and in many cases approaching zero, as the drum and lining surface temperature approximates 800 or 1000 F. This is the main cause of fade.

2. At low or medium temperatures, the wear rate on these organic lining materials is quite low, and the life of the blocks is good or excellent; but at higher temperatures, its wear rate increases and might reach as much as ten or twenty times normal. Fig. 2 shows how the friction and wear rate change with temperature in a typical truck or trailer brake lining.

3. Brake drums expand with increasing temperature, thus requiring more brake shoe travel and corresponding additional wheel cylinder piston displacement, whether it be an air or hydraulic system, to maintain pressure between the lining and drums. If the air cylinder, wheel cylinder, or master cylinder bottoms, the deceleration falls off. In addition, the radius of curvature of the drum as compared to that of the lining changes, producing decreased contact area and localized high temperatures. These are the secondary causes of fade.

4. At elevated temperatures, the strength of any commercial brake drum material is drastically reduced. Undoubtedly, brake drum irons at elevated temperatures likewise are softer and would have a greater tendency to score and to wear faster.

5. At higher ambient temperatures in the drum and brake, the problems of vapor lock, corrosion, frozen bearings, softened springs, and even tire fires are more prevalent. Perhaps it should be pointed out here that any improvement forthcoming from the lining manufacturers toward additional stability or lower wear might result in still better brakes. For example, even a slight increase in the lining characteristics might permit designing a smaller brake which, because of better circulation of air around the drum would offer greater benefits than can be attained through brake drum design only.

In the design of brake drums, certain physical and material characteristics are of major importance for maximum performance. The following contribute to lower drum temperature:

• *MASS*: The drum must have enough material in it to be able to absorb the heat generated in the peak power conditions of high-speed stops or snubs and store it at a low, safe operating temperature until it can be dissipated. Mass ties in with specific heat, since the product of mass and specific heat is thermal capacity.

• *SURFACE AREA*: The maximum surface area attainable is of utmost importance in lowering the brake drum temperature. Because most of the heat is dissipated from the brake drum by convection, the benefits gained from large surface area are quite obvious; and if the additional surface

area can be arranged in ribs or fins to increase the flow of air over the drum, extra benefits will be derived. Finally, although the amount of heat dissipated by radiation to the surrounding parts is relatively small compared to the heat convected, additional surface area increases radiation.

• *HOMOGENEOUS CONSTRUCTION*: This is desirable to avoid barriers to the flow of heat from the heat generating surface to the heat dissipating surface. This is particularly true of multipart drums having cast iron braking surfaces mechanically attached to a carrier made of high conductivity metal such as aluminum. It is also true to a lesser extent of bimetallic drums having cast iron liners supposedly bonded to high conductivity metal where either the bond was defective when the drum was made or became so through use.

• *EXPOSURE*: Again, because the majority of brake heat is dissipated by convection, it is imperative that the drum, or as much of it as possible, be exposed to the air normally passing by the brake drum, wheel, and tire. Likewise, it helps if the extensions in the form of ribs, fins, or other shapes act as scoops or impellers to increase the circulation of air.

• *SHROUDING*: Shrouding is closely associated with exposure but is more directly connected with designing the drum to leave as much space for air to circulate between the drum and the wheel rim as possible. We at Budd believe that although the flow of air over a drum through the space between it and the wheel rim is not continuous and steady but that there is turbulent and intermittent flow of air into and out of the space between the wheel rim and the drum. For that reason we attempt to make that opening as large as possible.

• *THERMAL CONDUCTIVITY*: High thermal conductivity in a brake drum material has two advantages. First, the higher it is, the faster heat is conducted away from the braking surface. High temperatures in the layer of surface iron results in reduced strength, promotes heat checking and causes high thermal stresses from localized temperature differentials. Second, higher conductivity results in higher temperatures on the heat dissipating surface thereby increasing the total heat dissipation. Thermal stresses are also reduced because of the more uniform temperature throughout the drum.

• *SPECIFIC HEAT*: Heat storage capacity, as mentioned in the section on mass, is needed in a drum to absorb and store heat during the peak power braking conditions, at low temperatures. Since heat storage capacity is the product of mass and specific heat, if it were possible to find a material having twice the specific heat of cast iron, a drum could be made with it to have twice the storage capacity at the same weight; or a drum made of it weighing the same as a cast iron drum could store an equal amount of heat at half the temperature rise of the cast iron drum.

• *EMISSIVITY FACTOR*: The emissivity factor, indicating the ability of an object to dissipate heat by radiation is of little consequence in brake drum design, since heat radiated from a brake drum is only a small portion of the total heat dissipation. Also, emissivity is largely a question of surface finish; and a rough, oxidized, or black surface has a much higher factor than a smooth, bright shiny surface.

Physical characteristics which contribute toward good performance and long life are:

• *STENGTH*: The strength designed into a brake drum is a combination of the physical dimensions and material characteristics. The need for strength in a drum quite obviously is to permit it to function properly for a long time under the severe mechanical and thermal stresses imposed. It must not only do this in its, as-designed, original condition but in its worn or re-bored condition.

• *RIGIDITY*: Rigidity, or its opposite, flexibility, must be designed into a brake drum to allow it to conform to brake-shoe deflection under load and still preserve, as nearly as possible, uniform pressure over the face of the lining.

Material characteristics which control the performance and life of a brake drum include: high thermal conductivity, high but stable coefficient of friction, high specific heat, low coefficient of thermal expansion, low modulus of elasticity, high melting or softening point, resistance to scoring, good wear resistance, and resistance to heat checking.

Cast iron best

Cast iron has long been known as the brake drum material which presented the best braking surface. It also has other advantages which are not so clearly understood. The recent work done with aluminum on passenger car drums and to a lesser extent on truck drums would lead some people to believe that cast iron may soon go by the boards as a drum material except for the braking surface. This is far from the truth. Fig. 3 shows the comparative advantages of a typical aluminum alloy and a typical cast iron. Only on two counts does aluminum excel when properly compared to cast iron.

Cast iron has, in addition to the better braking surface:

1. Lower cost per lb and per cu in.
2. Higher heat storage capacity per cu in.
3. Much higher emissivity.
4. Much less expansion with heat.
5. A much higher melting point.

Aluminum excels only in heat conductivity and in heat storage per lb. This latter advantage is offset by the fact that one pound of aluminum occupies more space than one pound of iron, and the space available for brake drums is generally limited.

To Order Paper No. 117T . . .
. . . on which this article is based, turn to page 6.

A feature of the

SAE Nuclear Energy Activity Committee

Rocks can provide nuclear fuel for 10^7 years

A report by

J. F. Black

Member, SAE Nuclear Energy Activity Committee

(Based on a speech by Dr. Alvin Weinberg at the Third Industrial Nuclear Technology Conference, Chicago)

FISSION — rather than fusion — will probably provide our principal ultimate source of nuclear energy, according to Dr. Alvin Weinberg, director of Oak Ridge National Laboratory. He bases this prediction on the following points:

- The amounts of uranium plus thorium available in the earth's crust are sufficient, conservatively, to take care of the energy needs of the human race for at least 10^7 years.
- The economical production of power from fusion presents problems that we cannot now be certain of solving.

Table 1 — Amounts of Deuterium, Li^6, U, and Th on Earth

Raw Material	Source	Ppm	Total Mass, tons	Energy Content, mw-days of heat	Will Last at 4×10^7 Mw (Heat) Rate, years
Deuterium	Sea	33	6×10^{13}	2.4×10^{20}	1.7×10^{10}
Li^6	Crust	5	10×10^{13}	4×10^{20}	2.7×10^{10}
U	Crust	4	8×10^{13}	0.75×10^{20}	0.5×10^{10}
Th	Crust	12	25×10^{13}	2.3×10^{20}	1.5×10^{10}
Total U + Th	Crust	16	33×10^{13}	3×10^{20}	2.0×10^{10}

Note: The basic data in this table are from p. 41 of "Principles of Geochemistry," by B. Mason. Wiley, New York, 1959.

Table 2 — Energy Required to Process Granite (Values in kw-hr per ton)

Quarrying, Crushing, Hauling	7-9
Acids	10-25
Other Direct Charges (Water Pumping, etc.)	1
Hidden Costs	0.7-2.3
Total	19-37[a]

[a] Approximately equal to 25-48 lb of coal.

Note: Data taken from p. 129 (Brown and Silver), "Production Technology of Materials Used for Nuclear Energy," Vol. 8 of "Proceedings of International Conference on Peaceful Uses of Atomic Energy." United Nations, New York, 1956.

Energy from rocks versus from ocean

If power is produced primarily by fission reactors, the nuclear energy resources of the human race will depend on the uranium plus thorium resources in the rocks. If fusion is the source of power, it will depend on the world's deuterium and Li^6 resources (both these isotopes can be used in the process). The amounts of these elements available and their significance in terms of energy availability are shown in Table 1.

Note that there is sufficient uranium plus thorium in the earth to provide an indefinite source of energy for mankind via the fission reaction. This is true even allowing for the fact that the amount of energy "practically" available from uranium plus thorium in the rocks is a great deal less than that given in Table 1. These reserves should not include, for example, the parts of the earth's crust under the sea or the material more than say, two miles below the surface. In addition, only about one-fifth of the uranium plus thorium (or 3 grams per ton) is contained in the rather easily leachable portions of the granites. Even if these and other considerations should reduce the figures in the table by a factor as great as 2000, the energy reserves available to the human race would still last for 10^7 years, which leaves ample time for other energy sources to be developed.

These conclusions also assume that all of the uranium and thorium will be burned, not just the natural U^{235}. This requires that breeding reactors be developed, a problem to which the AEC is now giving appreciable attention. Although the technology has not as yet been developed completely, there is no reason to believe at present that breeding cannot be accomplished successfully.

It is also assumed that uranium and thorium can yield more energy than is required to extract them

IN ADDITION to nuclear power, as discussed in the accompanying story, Dr. Weinberg expects that solar energy will supply some of the energy needs of future generations. He feels, however, that nuclear power will be the more important source, since solar energy will always be more expensive and less dependable, except for specialized uses, such as space heating.

The nuclear power plants, Dr. Weinberg anticipates, will supply energy not only for direct use but also for conversion to more convenient forms or for chemical reduction. For example, he says, small-scale mobile energy can be obtained by utilizing either electrical or chemical storage systems. An instance of the latter would be electrically produced hydrogen, which could be used in the production of liquid fuel hydrocarbons from carbonate rocks through the hydrocarbon synthesis reaction. All ores would be reduced electrically since coal would no longer be available.

Dr. Black has summarized Dr. Weinberg's talk for SAE Journal readers because of the importance of his conclusion concerning the ultimate sources of energy of the human race.

from the granites. According to authorities in the field, the cost of extracting the "easily" recoverable uranium and thorium at the 3 gram per ton level is equivalent to from 25–50 lb of coal or 19–37 kw-hr per ton of granite. The manner in which this figure is reached is indicated in Table 2.

Since 3 grams of uranium or thorium, completely burned, will produce 3 megawatt days of heat (equivalent to about 10 tons of coal), it is evident that the total energy reserves are increased by this extraction process.

The size of the mining operation required to meet assumed annual energy demands of 4×10^7 mw of heat would not be excessive even by present-day standards. Since the production of one megawatt of thermal power requires the consumption of approximately one gram of fissionable material per day, the total U + Th burned per day would be about 40 tons. This would require the mining of about 10^7 tons of rock per day. The world's daily production of coal and lignite in 1953 was 0.6×10^7 tons, a figure very close to this magnitude.

Fusion reactors

If nuclear power demands were to be satisfied via fusion reactors, it would be necessary to "mine" the sea for deuterium rather than the rocks for uranium plus thorium. We know that this could be done successfully since deuterium is already being produced from this source. If it becomes necessary to rely upon the $D + Li^6$ cycle for producing fusion power, the world would also be faced with a mining requirement for lithium which would be approximately equivalent to that just discussed for uranium plus thorium. There is no reason to think that this could not be handled in an equally successful manner.

The economical production of power from the fusion reaction, however, presents problems which we cannot now be certain of solving. To obtain fusion between deuterium nuclei, for example, it will be necessary to hold the ionized deuterium gas at a temperature of 400,000,000 K and a pressure of 60 atmospheres. Due to the temperature and reactivities involved, the pressure must be maintained by magnetic lines of force rather than by steel walls. It would be premature to say that economical fusion processes cannot be developed, but it would be equally incorrect to say that mankind's future energy supply is assured on the basis of what we now know about the fusion reaction.

AEC revises radioisotopes training program

THE AEC has revised its radioisotope training program for 1960 to make it easier for participants to take only as much training as they need. Thus, they can spend as little as two weeks, taking only the basic radiation physics course, or they can go on to take, in addition, a course in radioisotope research techniques or one in industrial radioisotope techniques. These two courses also last for two weeks, and are given simultaneously. There is also a 2-week advanced course in specialized industrial and research techniques.

These courses are given by the Special Training Division of the Oak Ridge Institute of Nuclear Studies, which has been operating for over 10 years and has trained several thousand American scientists, plus over 350 scientists from 56 other countries.

All costs of presentation are borne by the AEC, except for a registration fee of $25, which covers any continuous enrollment period. Convening dates for the rest of 1960 are February 29, May 2, July 25, and September 6.

For further information and application blanks, write to Dr. Ralph T. Overman, chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn.

Materials Selected

600 F Constant-Speed

Testing proves performance of materials in mechanical traction

Based on papers by

C. D. Flanigen

Lycoming Division, Avco Corp.

and

S. S. Baits and E. W. Kruger

Sundstrand Aviation Division, Sundstrand Corp.

THE ACCOMPANYING STORY describes how material and fluid problems were solved in two constant-speed drives.

These drives were designed under an Air Force program to develop a 600 F airborne electrical generation and distribution system.

The article is based on two papers — one by E. W. Kruger and S. S. Baits (Paper No. 102T) describing the Sundstrand hydromechanical drive, and the other by C. D. Flanigen (Paper No. 102U) on Lycoming's mechanical traction drive.

Electrical components and materials for the program were described in the November SAE Journal. The story, "600 F Airborne Electrical System Is On the Way," was based on a paper by John Pierro.

TWO CONSTANT-SPEED DRIVES are being developed under the Air Force 600 F airborne electrical system program — Lycoming's mechanical traction drive (Fig. 1), and Sundstrand's hydromechanical drive (Figs. 2 and 3). Materials and fluids have been selected for the respective drives. Extensive testing has demonstrated their compatibility and performance at operating conditions.

Selecting the best materials

Hydromechanical drive — Bronzes aren't very good as piston bores, sleeve bearings, and antifriction bearing retainers in 600 F hydraulic apparatus. So an intermediate air-hardening tool steel is used for most of the working parts, and its performance has been good. The trade name used by Latrobe Steel Co is MV-1 (it is being called M-50 throughout the industry but this is not an official AISI designation). Sundstrand specifies consumable electrode vacuum melt.

Mechanical traction drive — Selection of materials for the transmission (and the mechanical primary control) was more a concern for areas of rubbing contact and of compatibility with the operating fluid than merely strength at temperature. The following materials seem best so far:

Rolls and Toroids — Ferrovac Halmo and T-5 Rex Supercut.

Gears — Nitrided Inco 5% Ni-2% Al Super Nitralloy and SAE M-10 high-speed tool steels.

(continued on page 56)

for

Drives

and fluids

and hydromechanical drives

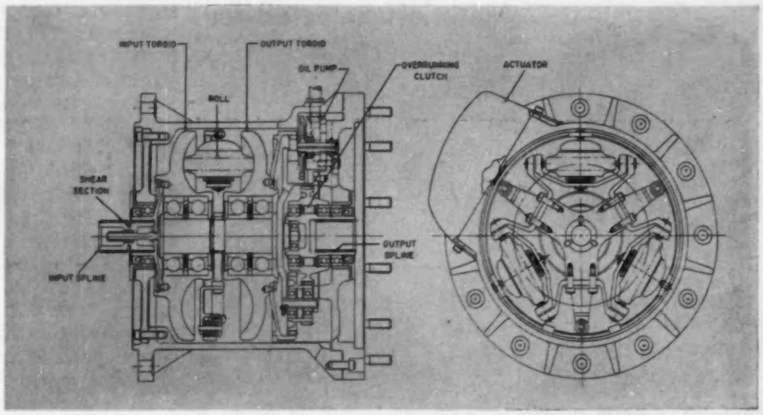


Fig. 1 — Lycoming mechanical traction constant-speed drive. Two adjacent flywheel members, called toroids, are concentric about the drive axis. Adjacent surfaces of toroids are dished to form a toroidal space. Rolls mounted in yokes fastened to a fixed cage within the toroidal space contact each toroid. Power is transmitted from one toroid to the other through friction because the rolls are easily steered from one roll angle to another to vary the speed ratio. Automatic speed controls adjust the roll position to maintain constant output speed.

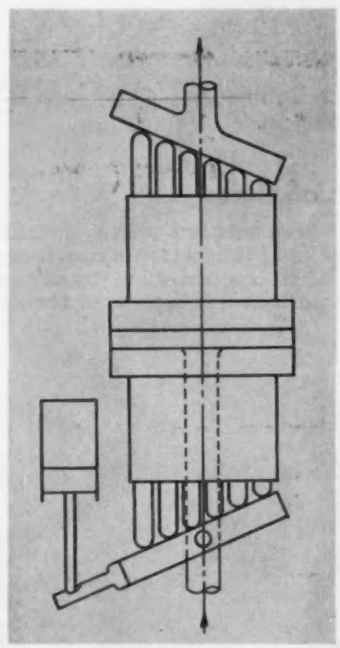


Fig. 3 — Schematic of Sundstrand transmission. It uses in-line hydraulic units and the two cylinder blocks are bolted together, to achieve differential action. The output element uses fixed displacement per revolution unit. In order to obtain differential action without gears, both crankshaft and cylinder block rotate on one of the units. Input element has variable stroke, and the transmission ratio is controlled by positioning the wobbler (or crankshaft) of the input unit. . . . This is readily done since it is stationary.

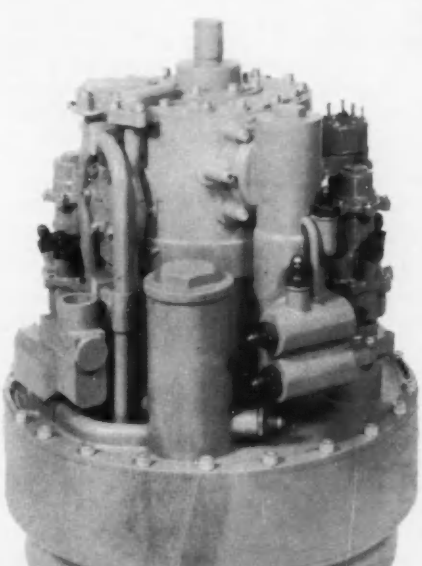


Fig. 2 — Mockup of Sundstrand hydromechanical constant-speed drive.

Materials Selected for 600 F Constant-Speed Drives

. . . continued

Bearings — Races and Balls — Ferrovac Rex Supercut, M-50 tool steel, AISI 440C stainless steel (equivalent to SAE 51440A).

Cages — Chromed-plated S-Monel, S-Monel, iron-silicone bronze.

Gear-Type Pump Elements — Nitralloy, M-10 tool steel, in a Meehanite housing.

Housings and Covers — AISI 304 stainless steel casting (equivalent to SAE 30304).

Structural Parts — Vascojet 1000 (equivalent to SAE H11).

Springs — Inconel X.

Shaft Seals — Aluminum oxide against flame-plated tungsten carbide.

Gaskets — Duroid 5600.
Raybestos Manhattan A56.

Overrunning Clutches — Outer race M-10; sprags and inner race M-50.

Transmission fluids

Traction transmission — The lubricating and cooling fluid is an important element in the power capability of a traction type transmission. The principal fluid that has been used for 600 F testing to date is General Electric F-50 with a blanket of nitrogen. This same fluid, without nitrogen, is used in lower temperature drives. Power capability is about the same at both temperatures.

Chemical testing on various other fluids shows that General Electric Syphenylene 1000 is the most stable for 600 F operation. Because it is virtually unobtainable in sufficient quantity, no transmission testing with this fluid has been accomplished to date. The next most stable fluid is GE 81644. (This is a combination of F-50 and iron octoate.) Some transmission testing with the 81644 has been accomplished. To date, the tests show a sizeable increase in power at the expense of roller wear. Further investigations are required before any definite conclusions can be made, but there is a potential increase in power capability.

Hydromechanical drive — MLO-8200 fluid (WADC designation) is used in the hydromechanical drive. This fluid, developed by the Oronite Chemical Co., is a silicate ester blend also described as a disiloxane-ester base fluid. The system is nitrogen-blanketed to extend fluid life. Working fluid is used for cooling and lubrication.

Viscosity is not a big problem, as shown in Fig. 4. Low bulk modulus is a concern . . . usable fluids have bulk moduli of about 45,000 psi at the high temperature (Fig. 5). However, very small passage lengths and modest pressure levels help reduce harmful effects of low bulk modulus.

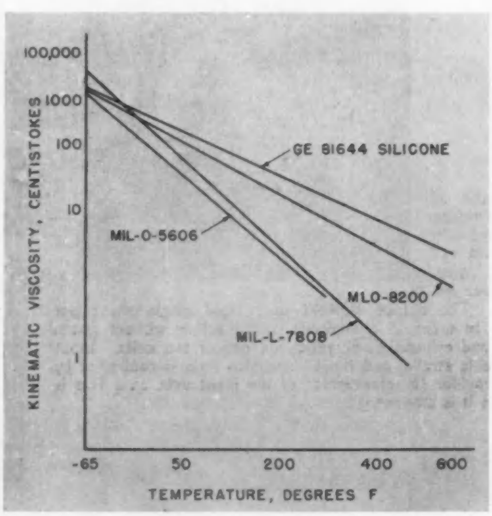


Fig. 4 — Fluid viscosity over required temperature range.

Testing methods, and some of the results

Mechanical traction drive — Typical mechanical components have operated individually and in combination at 600 F. About 90 hr of tests have been accumulated, with many more at temperatures above 400 F. A breadboard drive containing all the selected high-temperature materials has completed a 100-hr endurance test, 20 hr of which were at 600 F.

Hydromechanical drive — Electrical components were evaluated by subjecting samples to required operation and environmental conditions. Mechanical components were evaluated by bench tests and by operation of a complete experimental transmission at high temperature — one of which was run for 20 hr at 600 F and 80 hr at 400 F.

The friction and wear tester used by Sundstrand is Hohman Plating Co.'s model A-6. (Fig. 6 shows a schematic of the machine.) The samples are a rotating ring and two shoes which bear against the ring. The force exerted at the contact point is controlled by adding weight to the lever arm which forces the shoes in by the action of the cone cam arrangement. Friction is measured by a strain gage attached to the torque arm which holds the shoes. This permits the motion of the shoe required to measure the friction force to occur without changing the orientation of the contact area on the specimen. Shoe temperature is measured from a thermocouple embedded in the shoe. A wide range of speeds can be obtained from the Varidrive and by changing pulleys. Breakaway torques are measured by turning the shaft manually.

The specimen may be submerged in the fluid bath, which can be heated electrically to the desired temperature. The tester itself is enclosed in a box with sealed penetrations for the driveshaft and instru-

ment leads. This allows pressurization or inerting as required for test at high fluid temperatures. Good repeatability has been obtained on tests run on this machine.

Leaks were a constant headache during the testing program. For the sake of expediency some assemblies containing O-rings were used and even with Viton A material the life of these seals was limited to a few hours in places where movement occurred. The final design uses flat gaskets and metallic bellows for seals. These have been evaluated on rigs and will be satisfactory.

In order to obtain the high fluid temperatures, a special fluid reservoir was constructed. This is a tank in an insulated box with quartz tubes radiating to the exterior wall of the tank. This system allows heating the fluid without the danger of burning it with hot spots. The reservoir can also be used for fluid evaluation and component tests.

Electrical components were operated in a small oven for preliminary screening. Then the survivors were assembled into sample circuits and subjected to other environmental tests while operating. These included combined high-temperature and vibration, combined temperature and altitude, and acoustic noise. As may be suspected, it was the combined high-temperature and vibration tests that gave the most trouble. Every piece of equipment that passed that test, for instance, passed acoustic noise without difficulty.

The first circuit came back from the temperature-vibration test in the form of a multitude of tiny pieces poured in a coffee cup. The ceramic tubes were particular culprits in this regard. They perform quite nicely under the temperature conditions, but the manufacturers failed to provide adequate mounting provisions. The best method found for mounting the tubes is to mount the tube on the threaded holes provided and then cradle the tube in a ceramic cement.

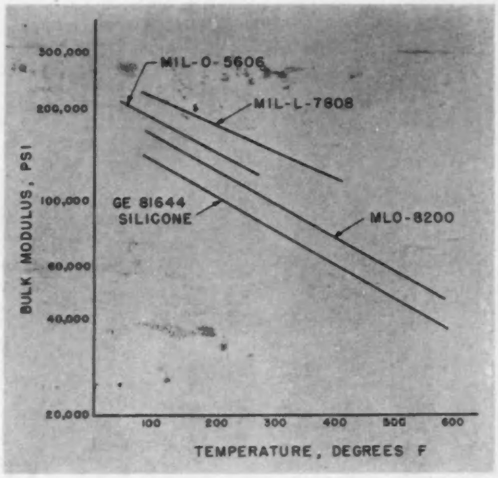


Fig. 5 — Bulk moduli of usable fluids at high temperature.

To Order Papers Nos. 102T and 102U . . .
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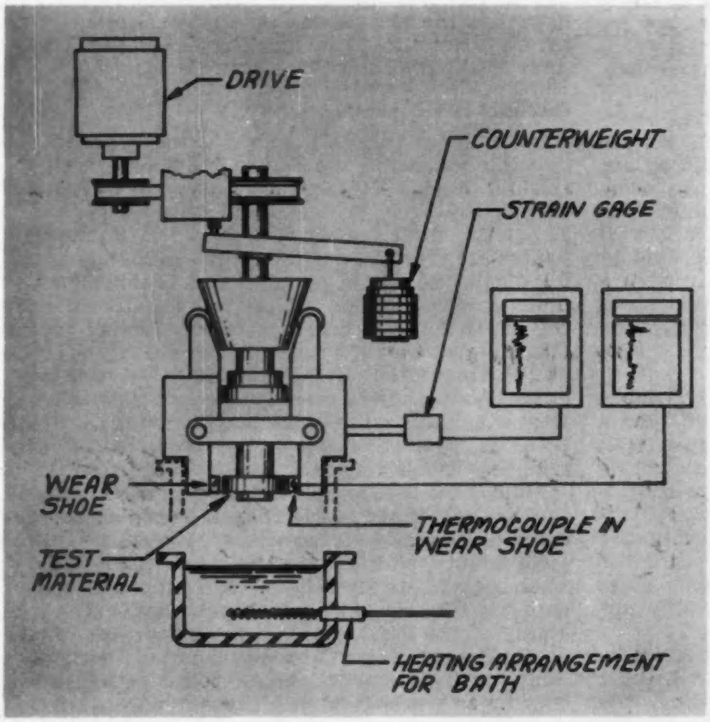

Fig. 6 — Schematic of Hohman Plating Co. Model A-6 friction and wear tester.

Quick, Low-Cost Test

Automatic Transmission

Based on paper by

H. E. Deen
and
C. M. Stendahl
Enjay Laboratories

USE OF VARIABLE test time is the key to Enjay Laboratories' new oxidation stability test for automatic transmission fluids. It avoids the exaggeration of oxidation conditions to shorten test time, which is common to all other test methods.

This oxidation bench test is based on the Powerglide L-37 transmission test, run at 300 F. And to simulate the limited contacting of the fluid by air, characteristic of that test, it is run in an oven. Eleven fluids can be evaluated simultaneously. The fluids are placed in glass beakers and agitated with glass stirrers to simulate agitation of the fluid in the transmission. A bronze thrust washer from a Powerglide transmission serves as the catalyst and the test is run at 300 F for a maximum of 300 hr.

Using time as a variable

To implement the concept that time is a variable, fluids can be sampled without opening the oven. Tubes are inserted in the oven and capped with spring oil caps so that long syringe needles can be inserted through the top of the oven to withdraw fluid samples.

Fluids are sampled at 24-hr intervals by filtering 15 drops through a small filter paper and rating the paper visually for sludge deposition. This gives quick results and the conclusions are readily apparent to even untrained personnel.

Filter papers from a test of a number of commercial fluids are shown in Fig. 1. Here the striking thing is the sharp break in the oil with time, the break point being the condition where sludge particles first appear on the paper.

For correlation studies, the break point in the bench test was related to a general description of the performance of ATF's in the Powerglide L-37 test. It was found that the oils which were poor in the L-39 test broke quite early in the bench test, usually in less than 100 hr. Fluids rated satisfactory or good in the transmission test broke at close to 120 hr, while fluids rated as excellent did not break until close to 200 hr in the bench test.

Results of correlation studies

More recent correlation studies were carried out between bench test and Powerglide test with air injection. A good reference fluid, supplied by General Motors Research, was used in both tests. Fig. 2 shows the filter papers from the two tests. The papers are rated on a standard demerit scale where 0 indicates no sludge particles and 10 represents so much sludge that the sample was unfilterable. In the bench test the break point was 192 hr; in the transmission the fluid was good for 192 hr but broke at 200. Inspection of the low and drive valve body at this point showed trace sludge and light varnish formation. Thus, the bench test predicted the break point as specified in the procedure for the Powerglide test with air injection.

Fluids that gave excellent results in bench tests as well as those that did poorly have shown similar results in Powerglide tests with air injection.

No sound evaluation of a test can be made without some idea of its variability. A limited amount of data has been obtained which indicates the repeatability of the break point in the bench test is very good. Depending on the relationship of the time of sampling to the actual break point, results could vary by as much as 24 hr. The standard deviation

Evaluates

Fluid Oxidation

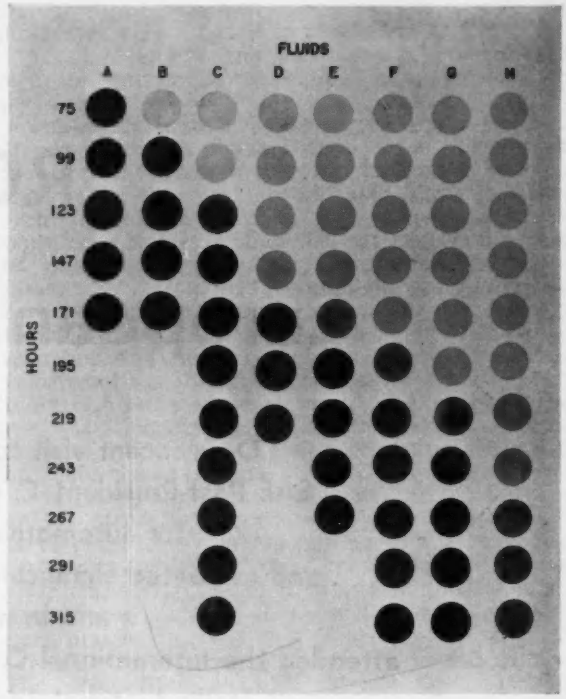

Fig. 1 — Filter paper ratings of commercial automatic transmission fluids in Enjay bench oxidation test show the sharp point in time at which sludge particles first appear. Fluids can be rated quickly and inexpensively with this bench test.

is 13 hr for fluids in the excellent stability range of 200–300 hr. This accuracy has proved entirely satisfactory for the work done thus far. Obviously, the standard deviation could be reduced by sampling more frequently than 24 hr.

What these studies prove

Time is a very important variable in studying the oxidation stability of ATF's. Once the oxidation inhibiting properties of a fluid has been spent, sludge and varnish formation proceed at a rapid rate. In both bench and transmission tests, which are run for a fixed period of time, this phenomenon could easily result in misleading conclusions about the relative quality of an ATF. An excellent example of this is provided by CRC reference fluid C, shown in Fig. 1. The actual break point which occurs between 99 and 123 hr in the Enjay bench test characterizes the fluid as being of borderline quality in the Powerglide L-39 test. In other words, it is a fluid which has a break point close to 300 hr in the transmission test. This makes it ideal as a reference fuel if time to break point is measured. But if transmission results are analyzed only after 300 test hours, it might well be a poor reference oil. This is because the normal test variability would probably result in transmissions ranging from very clean to very dirty, depending on how close the break point was to 300 hr.

These studies also point out the importance of regular changes of ATF's to the automobile owner. A fluid might be quite satisfactory up to the recommended drain period, but after another few thousand miles could be badly degraded and cause troubles if left in the transmission.

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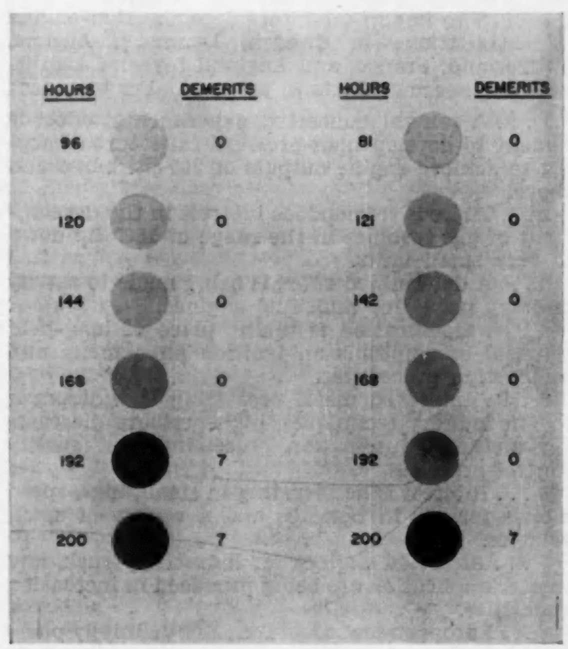


Fig. 2 — Comparison of Enjay bench test results on the left with Powerglide test (air injection) results on the right, using a good reference fuel, shows close correlation.

ROSEN reports on European engine research

On a recent visit to European manufacturers of diesel engines, SAE Past-President C. G. A. Rosen investigated multifuel systems for automotive-type equipment designed for the military . . . and evaluated significant developments in combustion systems . . . and in materials and production methods. He also attended the International Congress on Internal-Combustion Engines and talked intimately with the leading European diesel engineers who comprise the Congress.

In this "Overseas Report to SAE Journal," he details the most significant of the impressions he has brought back.

VISITS to important internal-combustion-engine installations in Sweden, Denmark, Austria, Switzerland, France, and England revealed significant engineering efforts in progress. For instance:

1 . . . A general, concerted, experimental effort is evident to develop high-pressure-ratio turbocharging to achieve engine outputs of 200-psi bmep and above.

2 . . . There is tremendous interest in the development of gas turbines in the range of 1500 hp down to very small units.

3 . . . A determined effort is being made to satisfy military needs for multifuel engines.

4 . . . Modification is taking place of long-held classical assumptions on ignition phenomena and combustion procedures.

5 . . . Improved metal processing is widespread . . . in foundry techniques, high-pressure die-casting methods, automation processing, and quality control practices.

6 . . . Interest is accelerating in small, high-speed diesels for use in taxicabs and a variety of small vehicles.

7 . . . Aircooled engines for industrial, truck, and tractor application are being produced in increasing quantities.

8 . . . European manufacturers are definitely planning invasion of both the United States and outside-of-United States markets now held by American manufacturers.

The road to higher bmep's

Every European laboratory, it is very evident, is trying to get higher bmep's by way of high-pressure-ratio turbocharging.

The Swedish engine builders particularly are working in this direction, reasoning that the diesel is a natural for turbosupercharging.

The compression-ignition, they point out, thrives on excess air-fuel ratios. By utilization of excess air-fuel ratios, the unit has a higher and more uniform output over a wide range of temperature and altitude conditions. This permits the burning of lower grade fuels to economic advantage.

In some efforts to develop very high bmep's—as in one specific German engine for instance—the cylinders become smaller. But the higher peak pressures and high torque reactions are responsible for heavy structures in frames, crankshafts, and bearings. The point of minimum return may be achieved in boosting supercharging to much higher pressure ratios than are now being attempted. A 3/1 pressure ratio, however, is quite in the cards for current demands.

142 labs on gas turbines

Some 142 laboratories around the world are known to be experimenting with or building gas turbines in the range of 1500 hp and smaller. Their

configurations have all manner of geometry . . . from the simple, single-shaft, nonregenerative unit to the assembly of multiple turbines, multiple compressors, heat exchangers, intercoolers, and reheat devices.

One extreme tends toward simplicity, with the known penalty of higher-than-usual fuel consumption, but with lower maintenance costs when good-load-factor installations can be selected. The vehicle-type gas turbine, on the other hand, calls for fuel economies competitive with the diesel. So, it requires combinations of units and more complex geometry of structures to produce good part-throttle economy.

There are some attempts being made to combine the gas turbine with the diesel engine for military vehicle applications where 40% of the operating time may be idle and 40% in the range of 25-30% load. This load situation can be normally taken care of by a good diesel engine in a small package configuration. The 20% maximum load can be carried by an amplified powerplant to the diesel in the same gear train by a floating-type gas turbine. This combination will provide the increase of power when demanded at short notice. It is highly desired also in arctic operations. There, starting at low temperature would otherwise require kits to the diesel. But the gas turbine can be started quickly and its exhaust utilized to heat up the diesel engine as well as to provide a starting motor, thus giving operational functioning at extremely short time intervals.

Multifuel engines for military

The military requirement for multifuel engines has developed programs in Germany, France and England for burning 83/91 octane combat gasoline. It may be possible to divide these developments into three classifications. But a combination of all categories may be required to achieve a universally successful multifuel engine for severe American military services at operating conditions from ambients of –65 F to 125 F.

German research programs to achieve multifuel engines all utilize high compression ratios to heat surfaces which will permit rapid evaporation of some portion of the fuel spray to achieve the nucleus of ignition. The compression ratios which have been experienced range from 20/1 to 26/1. No definite ratio can yet be claimed as the ultimate for a multifuel engine. The four German developments include the MAN, a 4-stroke liquid-cooled system, with an open combustion chamber. The MAN uses a heated, convex piston cavity to achieve temperatures which assist in the evaporation of the fuels sprayed against its surface.

Dr. J. S. Meurer, the developer of the MAN, so-called M System, indicates that the successful burning of combat gasoline is;

1. Influenced by the character of surface on which fuel is injected.
2. Related to the temperature of the surface on which the fuel is injected as an influencing factor on evaporation speed.
3. Influenced importantly by how the fuel is pretreated before striking the hot surface.
4. Influenced by the vortex of the turbulent air at controlled velocities and directions to give the untreated air a chance to pick up fuel.
5. Dependent on the fuel being injected into a definite region to permit high-speed operation with satisfactory combustion.

The MWM System, as developed by Dr. Hans L. Hockel, utilizes a double throat in the prechamber arrangement wherein the fuel strikes a venturi in the central throat which is heated by its isolation from the cooling surfaces to temperatures which permit the bouncing off of fuel particles in the form of vapor, thus accelerating ignition in the vapor phase. By arranging a double throat having an inner venturi surrounded by an outer annulus, a balance in pressures is obtained between the prechamber and main chamber. This reduces the velocity of flow of high-temperature gases against the piston surfaces, which are shaped to deflect the fuel to unburned regions for completion of combustion. The MWM is a 4-stroke, either aircooled or liquid-cooled, engine.

The Mercedes-Benz is a liquid-cooled, 4-stroke engine utilizing a prechamber with isolated surfaces permitting the rebounding of fuel particles into vapor, which are more readily ignited by the high temperatures at high compression ratios. This prechamber engine is of the well known Mercedes-Benz design.

The Deutz is a swirl-chamber, aircooled engine. The combustion chamber directs the injection stream in opposition to the direction of the turbulent air currents. A single-hole pintle nozzle is used. The main effort in development of this engine into one capable of multifuel operation is toward uniformly high combustion cylinder wall temperatures.

The Deutz engine makes use of the regulation of aircooling and combustion gas temperatures to control the cylinder wall temperatures. Also, the preheating of the intake air assists in achieving terminal compression temperatures suitable for ignition of combat gasoline.

A second category of multifuel engines may be considered a double-injection method. This idea has been promoted for uses other than multifuel engines of the military classification. Prof. Paul H. Schweitzer has developed it for railroad use as a fumigation method. Here a very finely divided mist is introduced in the inlet manifold and precombustion reactions take place in the mixture so introduced, prior to the time that the main charge is injected.

At the Institut du Francais Pètrole a method has been evolved in which a preliminary charge is introduced immediately after the exhaust valve is closed. The hot residual gases which still remain in the cylinder provide temperature for the preheating of the initial fuel to cause its evaporation and retain an atmosphere which is not oxidizing in order to generate the desired reactions. These reactions are halted when the admission valve introduces fresh air, quenching the procedure to the point where preignition does not take place. Later introduction of the main charge at the end of compression into a chemically conditioned mixture that is ready for ignition produces a smooth and orderly combustion procedure.

The logic of this system can be observed by considering the effect of various physical characteris-

Rosen reports on European engine research

. . . continued

tics of the fuel influencing the physical ignition lag. Over and above this lag is a chemical lag, which is altered by the percentage of aromatics and other components that are present in the fuel and ultimately determine the total ignition delay. A formula for the physical delay period, based on the equation of delay time from the beginning of injection (time $=0$) to time t_1 (the time of self-ignition as influenced by physical delay factors) is deduced in Appendix A.

From the equations given in Appendix A, it can be seen that the significant factor in the formula for physical lag time is the square of r, which is the radius of the fuel drop or the film thickness of the vapor. Equating r close to zero or approaching zero means that t_1 approaches zero.

The other factors in the equation have reference to the physical characteristics of the fuel and the thermal conditions prevailing at the time of ignition. From this it can be seen that, with the approach to a minimum diameter r (or complete vaporization of the fuel droplet) the time lag approaches minimum values. This is a feature of the Institut du Francais Pètrole method as well as the preconditioning of the charge with reference to its chemical characteristics. This feature has been stressed in Prof. Paul Schweitzer's "fumigation" system.

The higher aromatic fuels have a longer chemical lag. In the presence of sufficient oxygen they react rather violently. Under the conditions influencing the pre-charge (1) (a non-oxidizing atmosphere) when evaporation takes place and (2) subsequently subjecting the mixture to a chilling effect, (3) followed by increased oxidation, the fuel is eventually prepared for ignition of both the initial and main charges.

The third category can be considered that involving reduced heat transfer from the compression space to the cooling medium. This system was approached experimentally by the British and indicated that long stroke/bore ratios were better igniters of low cetane fuel than short stroke/bore ratio engines. From this it was deduced that in the opposed-piston engine, having stroke/bore ratios of the air mixture of at least 2/1 to 2½/1, the opportunity for designing a combustion space more nearly approaching a sphere where the surface to volume ratio is ideal, results in the minimum exposure of cylinder surface or water-cooled surfaces to the air of compression. By utilizing the opposed-piston principle, no cylinder heads are involved and piston contours can be controlled in temperature by air cooling. By making the combustion space more nearly spherical, the surface of the cylinder exposed to the compressed air represents minimum values.

In the 2-stroke opposed-piston engine the reciprocating forces permit the utilization of heavy piston crowns, which can be made of heat resistant steel and thus retain a high surface temperature, greatly assisting in raising the terminal temperature of the air and accelerating ignition conditions. It is known that combat gasoline requires almost 350 F higher temperature to achieve self-ignition than is required by a conventional diesel fuel. A simple way to achieve this result is to utilize a high stroke/bore ratio wherein the heat losses to the surrounding media are reduced to a minimum.

The British multifuel engine for military uses, from minimum horsepowers to maximum, involves development of opposed-piston engines as initiated by the Fighting Vehicle Research and Development Establishment. They claim that in the uniflow opposed-piston 2-stroke engine the stroke/bore ratio is higher than for any other type, and, at equivalent dead center, the area of cooled combustion chamber is the minimum. At the same time the available space for parasitic air is also a minimum. Further, by the use of tangential inlet ports a high degree swirl can be imparted to the incoming air. The system can be further enhanced by the use of two-part pistons where the crown is virtually insulated from the skirt by reason of the small area of contact between them. This enables the crown, which is of a heat resisting steel, to run at a much higher temperature than is usually possible.

Byproducts of multifuel research

Development work on multifuel engines has yielded a byproduct of increased knowledge of the combustion process. It has made for better diesel engines of the conventional type. In the search for new information some of the more classical assumptions on ignition phenomena have been modified. The work of Dr. Meurer, Dr. Hockel, and the Ricardo Laboratories has presented new concepts of ignition and combustion that will enhance the opportunities for the compression-ignition engine in greater utility and usage.

The colored photography which has been accomplished by Alcock of the Ricardo Laboratories, as disclosed in his paper, "The Combustion Process in High-Speed Diesel Engines," is of major significance. It has been shown in these photographs that fuel is ignited in the extremely finely divided evaporated stage of fuel film which is even beyond photographic delineation. Here ignition takes place at its nucleus and spreads along the fringe of vaporized fuel, bouncing off from heated surfaces in the combustion chamber.

Dr. Meurer has pioneered in methods which have improved ignition and reduced ignition delay, making it possible to burn low cetane fuels and combat gasolines.

Dr. Hockel has done similar work in his laboratory in Mannheim and has achieved some significant information on tests conducted in bombs, where heated air is introduced into a chamber and dual injection takes place. The initial injection is a reference fuel, after which chemical constituents or other components in the fuel are introduced in a secondary injection to accelerate or decelerate the ignition and combustion phases as desired.

Advances in metal processing

Hanomag is building a 2-stroke, loop-scavenged engines without machining of ports, which still achieves high precision of performance and pro-

Appendix A

Derivation of Formula for Physical Ignition Delay

As shown in Fig. 1, total ignition lag is a composite of physical and chemical lag.

Physical lag time (t_1) is expressed by the equation:

$$\int_0^{t_1} dt = \frac{r^2 \gamma_f c_p}{3k} \cdot \int_{\theta}^{\theta_i} \frac{d\theta}{(\theta_c - \theta)}$$

where:

r = Radius of fuel droplet or thickness of fuel film
γ_f = Specific weight of fuel
c_p = Specific heat of fuel
k = Thermal conductivity of air
θ = Fuel temperature
θ_c = Temperature of air of combustion
θ_i = Self-ignition temperature of fuel

Solving the equation for t_1 gives:

$$t_1 = \frac{r^2 \gamma_f c_p}{3k} \log_e \frac{(\theta_c - \theta)}{(\theta_c - \theta_i)}$$

Note that the significant factor influencing ignition lag is the radius of the fuel droplet, as it enters the equation as the square.

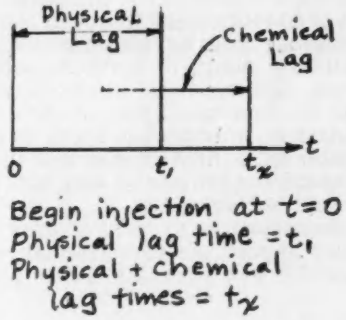


Fig. 1 — Diagrammatic sketch showing relationship of physical lag and chemical lag.

duction control. This is accomplished by the introduction of highly accurate coring and molding techniques, using plastics and coin pressed dryers.

It is also significant that high-pressure die casting has achieved a very enviable place in metal processing. Without machining Bosch is making fuel pumps, housings, and pressure chambers of die castings which have high densification and extremely accurate surfaces.

There are other instances, such as in the Hanomag production of 2-stroke loop-scavenged engines, utilizing Roots Blowers, where housings are die cast and rotors are die cast within very close limits, with minimum surfacing required to achieve desired efficiencies.

It is well known that the automation which has been achieved by Renault is of major interest. The production of high quantities of cylinder blocks by automated processes with accurate quality controls is of significance. Also at the Renault plant the utilization of casting techniques for cylinder liners and crankshafts with stress-relieving and surface treatment processes yield high wear resistant surfaces and low fatigue failures.

There are a great number of European manufacturers who introduce quality control stations at many points in the production line to minimize the number of rejects at the end of the machining schedules, thus minimizing the problem of assembly inspections.

As has been noted, there is an accelerated interest in small high-speed diesel engines for vehicles such as taxicabs. Some engines of the heavy-duty spark-ignition type have been successfully converted to compression-ignition engines, as, for example, by Dr. List's laboratory at Graz, Austria, and Ricardo in England. It is also significant that one-third of the Mercedes-Benz production of engines per day consists of compression-ignition engines installed in vehicles for passenger use.

The growing demand for aircooled engines is making important inroads in industrial applications. For instance, in the Deutz plant at Cologne, aircooled 4-stroke engines are built in such quantities that they are virtually hung on racks like bananas before shipment. They are installed in all manner of industrial vehicles, trucks, railcars, and other equipment. Similarly, manufacturers, such as MWM, have a high production of small aircooled engines and stockpile these engines for immediate deliveries for wide acceptance. The range of powers most demanded in aircooled designs is from 4 hp to 300 hp, with the major emphasis in the range of 200–250 hp.

It is quite evident that all European manufacturers are watching the rising cost of labor in America and its influence on material costs. This is leading the progressive European manufacturer to believe it is timely to consider invading American markets in Africa, South America, and eventually in America itself.

It is a well-known fact that a number of American manufacturers are now producing in quantity in various European countries as well as in Japan, at much lower manufacturing and assembly cost. It is generally felt that an invasion of American markets is on the way and will prove of much concern to American manufacturers.

It is of interest to know that a large number of American internal-combustion-engine manufacturers are utilizing the talent of European research laboratories and engineers for the development of new types of engines. The development cost in European laboratories is far less, in some cases, possibly 25-30% of that which such developments would cost in America. This will prove of much influence to the future products of American internal-combuston-engine manufacturers.

Tests Evaluate

and

Move to single TAF is speeded

Based on paper by

Norman A. Hunstad, Robert A. Wilkins, Robert E. Osborne, and Ellard D. Davison, Jr.

General Motors Research, GMC

TESTING is the backbone of the transaxle fluid development of GM Research. Through testing, five promising transaxle fluids have been screened out of 32 mineral-oil-base fluids, 10 synthetic-base fluids, and numerous additive-base stock combination fluids. While the final proof will be the field tests in actual transaxles, industry can speed its progress toward a suitable single fluid by observing the results of the many bench and proving ground tests adapted to transaxle fluid testing by GM.

Transaxle fluids have an impressive array of properties of major importance to performance, which require exhaustive test screening. These properties include:

- High-temperature viscosity.
- Low-temperature fluidity.
- Shear resistance.
- Friction properties.
- Oxidation resistance.
- Antifoam quality.
- Effect on seals.
- Fluid-clutch plate compatibility.
- Antiwear quality.
- Extreme-pressure quality.

In addition, antirust and anticorrosion quality also play an important role in fluid evaluation.

Plumbed car testing

The plumbed car was one approach to transaxle fluid testing when a production automatic transaxle designed to operate with a single reservoir was not available.

In the plumbed car, the fluid of the separate transmission and axle is mixed during testing. This is done by pumping the fluid between the two components during test driving. (See Fig. 1.) In this way the effect of both components on the fluid and the "mixed" fluid on the components can be evaluated.

An example of this type of interaction testing occurred when phosphate coating was applied to the axle hypoid gears in an effort to reduce the transaxle lubrication requirements. There was some concern whether phosphate wear particles in the fluid would cause malfunction of the transmission. Plumbed car tests indicated there probably was no contamination problem.

Another way of achieving "interaction" testing is to periodically mix the fluid being tested in the separate axle and transmission. This technique does not give the continuous mixing of the plumbed car but does eliminate the mechanical problems that can arise with plumbed cars. For example, Table 1 shows some results of plumbed car testing. In two cases the test was discontinued because of plumbing failures. (The first test was discontinued because the fluid showed undesirable properties in other tests.)

Fluid shear stability is another important factor that can be evaluated by plumbed car testing. Test evidence indicates that the axle has a higher shearing rate than the transmission, probably due to high pressures and sliding velocities between hypoid teeth. The loss of viscosity of a shear sensitive fluid due to axle shearing may cause transmission malfunction since it is known that automatic transmissions can be sensitive to viscosity loss resulting from fluid shearing.

Bench and proving ground tests

"Normal severe abuse" of cars in customers' hands still may rule out fluids that have passed a plumbed car test. Accordingly, tests are chosen which have for many years been used to evaluate transmissions, axles, and their lubricants. The battery of tests used is shown in Table 2.

This series of tests was used to further screen out the usable contenders from the 32 mineral-oil-base fluids submitted for test. Three came through (see Table 3) sufficiently to warrant further investigation.

An example of how one of these tests also pointed the way to proper phosphate coating of hypoid gears is illustrated by Fig. 2. Gears with a fine-grain phosphate coating passed the GMR Hypoid Gear Test for Transaxle Fluid, No. 2, while the coarse-grain surfaced gears failed when tested with the same fluid.

Additive testing

Another test approach to transaxle fluid development is to isolate the effect of additive concentra-

tion and composition. Since extreme-pressure (e-p) additives are one of the most critical, they were examined in detail.

The initial step is to eliminate the e-p effects of additives intended primarily for such qualities as anti-squawk and oxidation inhibition. To do this, an additive carrier was blended with no known e-p qualities. This carrier was also made to give viscosities in the automatic transmission fluid (ATF) range. Incremental effects of different additives could then be studied without the masking effects of other mildly e-p active agents.

Testing in a fully compounded transaxle fluid (TAF) is still necessary when a promising e-p additive is found. This is pointed up in Table 4 where the results of additive testing are reported. Di(n-octyl)phosphite (DOP) gave a ring gear rating of 2 when added to an automatic transmission fluid while the same 2% DOP concentration in the additive car-

42 TAFs* Additives

by GM bench and field tests.

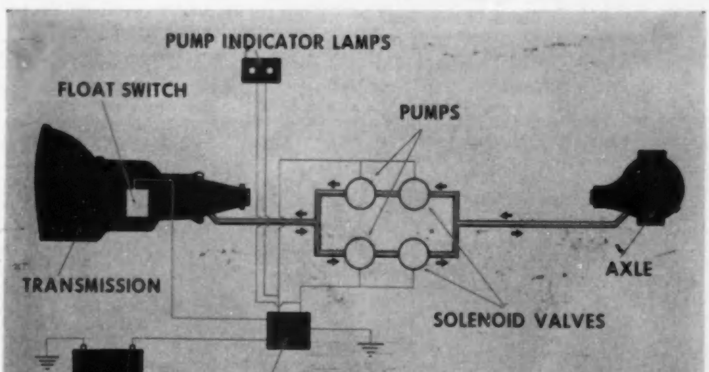


Fig. 1 — Plumbed car circuit diagram.

**Transaxle fluids.*

Tests Evaluate 42 TAFs and Additives

. . . continued

rier gave a zero rating. There is apparently an interaction between DOP and the other additives in the ATF.

Results of additive testing

Three additives showed promise as a result of the gear testing of 20 fluids shown in Table 4. They are:

Treated tri(2-chloro-1-methylethyl)phosphite
Di(n-dodecyl)phosphate
Di(n-dodecyl)phosphite

The last of these additives provided a link between chemical composition and mechanical performance when it and two related compounds were tested. Di(n-dodecyl)phosphite has a carbon chain containing 12 carbon atoms. Other related compounds having carbon chains containing 4 and 8 carbon atoms were also tested. All three had satisfactory gear lubricating qualities, but their compatibility with clutch plate friction materials *increased* with the length of the carbon chain. Additives with longer carbon chains, such as C_{18}, were considered but appear to be impractical because of solubility difficulties.

To Order Paper No. 117A . . .
. . . on which this article is based, turn to page 6.

BE SURE TO SEE PAGES 68 and 69 describing two tests that played a major role in transaxle fluid testing . . .

Table 1 — Plumbed-Car Test Results

Car	Transmission	Proposed Trans-Fluid axle	Total Miles	Remarks
Buick	Dynaflow	O	14,435	Test discontinued, no failure
Buick	Dynaflow	P	15,868	Mechanical failure of plumbing circuit
Oldsmobile	Hydra-Matic (controlled-coupling)	Q	23,400	Mechanical failure of plumbing circuit
Pontiac	Hydra-Matic (controlled-coupling)	A	21,000	25,000-Mile General Durability Schedule-pinion bearing failure
Oldsmobile	Hydra-Matic (controlled-coupling)	A	18,000	Car is still in service

Table 2 — Tests Used for Evaluating Transaxle Fluid

Test[a]	Requirement
Plumbed Car Test	Operation under customer-type driving conditions
GMR Hypoid Gear Test for Transaxle Fluid, No. 2	Hypoid-gear tooth-surface protection Hypoid-gear frictional noise (reverse noise) prevention
Powerglide Transmission Inertia Cycling Test	Clutch-plate lubrication
Chevrolet Fade Test	Clutch-plate lubrication
Hydra-Matic Transmission Inertia Cycling Test	Clutch-plate lubrication Viscosity stability Oxidation resistance and thermal stability Seal compatibility
Proving Ground 5000-Mile LL Schedule	Lubrication of clutches and other transmission parts
Powerglide Oxidation Test (CRC Designation L-39)—with and without air	Oxidation resistance and thermal stability
Tentative Procedure for Brookfield ATF Analysis	Low-temperature fluidity
Seal Dip Cycle Test	Seal compatibility
Total Immersion Test (ASTM D471-57T)	Seal compatibility

[a] Details of these tests are presented in Paper No. 117A.

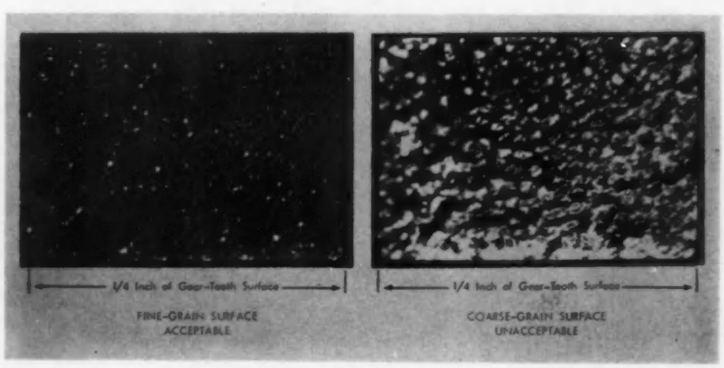


Fig. 2 — Variation of phosphate coated gear surfaces.

Table 3 — Mineral-Oil-Base Fluids to Be Further Investigated

Fluid	GMR No. 2 Gear Test	Chevrolet Fade Test	Proving Ground 5000-Mile 7/11 Schedule	Powerglide Inertia Cycling	25,000-Mile General Durability[a]	Powerglide Oxidation[d]	Viscosity-Temperature Characteristics
A	Pass	Pass	3 tests: 1 pass, 1 borderline, 1 fail at 4800 miles	3 tests: pass	Pinion bearing[b] failure at 21,000 miles	Condition 1: pass Condition 2: fail	Pass
B	Pass	Pass	—	—	—	—	—
C	Pass	Pass	—	2 tests: pass	Pass[c]	Condition 1: pass Condition 2: fail	Pass

[a] The 25,000-Mile General Durability Schedule is run at General Motors Proving Ground as a final test of car performance. It includes a wide range of driving conditions.
[b] Plumbed-Car Test using a Pontiac—pinion-bearing failure may have been due to oil starvation resulting from circulation system failure.
[c] This test was run 35,000 miles using a Chevrolet.
[d] Test run under both conditions 1 and 2.

Table 4 — Additive Evaluation Studies

Base Fluid	Additive	Concentration by Weight, %	Extreme-Pressure Quality: GMR No. 2 Gear Test: Gear Rating[b] Ring	Gear Rating[b] Pinion	Noise Rating	Clutch Plate Compatibility: Powerglide Transmission Inertia Cycling Test	Hydra-Matic Transmission Inertia Cycling Test	Proving Ground 7/11 Schedule	Chevrolet Fade Test
Proposed automatic transmission fluid	—	0	1	3	Heavy reverse	—	—	—	—
Additive carrier[a]	—	0	5	5	Medium	—	—	—	—
Proposed automatic transmission fluid	Di(n-octyl)phosphite	2	2	2	Trace	—	Pass	Fail	Pass
Proposed automatic transmission fluid	Di(2-ethylbutyl)phosphite	2	5	5	Heavy noise	—	—	—	—
Proposed automatic transmission fluid	Di(2-butyloctyl)phosphite	1½	2	4	Medium	—	—	—	—
Proposed automatic transmission fluid	Di(2-ethylhexyl)phosphite	2	5	5	Heavy noise	—	—	—	—
Additive carrier[a]	Di(n-octyl)phosphite	2	0	2	Trace	—	—	—	—
Additive carrier	Tri(n-dodecyl)trithiophosphite	2	5	5	Very noisy	—	—	—	—
Additive carrier	Di(n-dodecyl)phosphite	2	0	2	Trace	—	—	—	—
Additive carrier	Di(n-octadecyl)phosphite	2	0	1	None	—	—	—	—
Additive carrier	Treated tri(2-chloro-1-methylethyl)phosphite	2	0	0	Trace	—	—	—	—
Additive carrier	Di(n-dodecyl)dithiophosphite	2	4	5	Heavy reverse	—	—	—	—
Automatic transmission fluid I	Dibenzyldisulfide	2	3	4	Heavy growl	—	—	—	—
Automatic transmission fluid I	Lead di(n-amyl)dithiocarbamate	3	5	5	Growl	—	—	—	—
Automatic transmission fluid I	Zinc dialkyldithiophosphate	3	3	4	Heavy reverse	—	—	—	—
Automatic transmission fluid I	Chlorinated wax	2	5	5	Heavy whine	—	—	—	—
Automatic transmission fluid II	Di(2-chloroethyl)vinylphosphonate	2	4	4	Medium	—	—	—	—
Automatic transmission fluid II	Di(n-butyl phosphite	2	—	—	—	3 tests: fail	—	Fail: 1099 miles	—
Automatic transmission fluid II	Di(n-dodecyl phosphite	2	—	—	—	2 tests: borderline	—	—	—
Automatic transmission fluid III	Treated tri(2-chloro-1-methylethyl)phosphite	1	—	—	—	—	—	—	Fail
GMR transaxle blend No. 1313	—	—	0	2	Trace	Fail	—	—	—
GMR transaxle blend No. 1319	—	—	0	2	Trace	—	—	—	—
GMR transaxle blend No. 1320	—	—	3	4	Trace	—	—	—	—

[a] Additive carrier: 95.5% (by weight) automatic transmission fluid base stock, 4.5% (by weight) viscosity index improver, 20 foam inhibitor.
[b] Scale of 0 (no teeth surface distress) to 5 (very bad distress); 3 borderline.

Tests Evaluate 42 TAFs

These two tests played a

1 . . . . GMR Hypoid Gear Test for Transaxle Fluid, No. 2

Also referred to as "Oldsmobile Schedule No. 26 Test (modified) or "Oldsmobile Double-Bump Test"

This test is used to evaluate transaxle fluid performance in an axle. Use an Oldsmobile Super 88 for this test.

(1) Install new differential assembly and test lubricant.

(2) Warm up car for five laps of track at 40–50 mph. Avoid fast acceleration or deceleration.

(3) Test for drive, float, and coast noises at speeds up to 75 mph.

(4) Make 10 wide-open-throttle accelerations from 60 to 100 mph, decelerating with closed throttle. These are to be successive.

(5) From a stop (stall with brakes on and wide open throttle) release brakes and accelerate in drive range wide open to 50 mph. Pull shift lever into low range and let car coast down to stop with closed throttle.

(6) Repeat No. 5 except accelerate to 60 mph.

(7) Repeat No. 5 except accelerate to 70 mph.

(8) Repeat the 10 wide-open accelerations from 60 to 100 mph as in No. 4.

(9) Test for drive, float, and coast noises as in No. 3.

(10) Repeat Nos. 4, 5, 6, 7, 8, and 9.

(11) Test for reverse noise on 11.6% hill.

(12) Disassemble differential and inspect all parts.

The requirement for this test is absence of noise, wear and geartooth surface distress.

2 . . . . Powerglide Transmission Inertia Cycling Test

Scope:

1. This test procedure is intended for determining the operating performance of transaxle fluids in a Powerglide transmission.

Outline of Method:

2. A test fluid is used in a Powerglide transmission which is run 5000 cycles or number of cycles to failure. The duration of each cycle is 12 sec, 6 sec open-throttle acceleration, through the upshift range, and 6 sec closed-throttle deceleration.

Apparatus:

3. a. Chevrolet engine with a 4-barrel carburetor.

b. Rebuilt Powerglide transmission using Type A or B clutch plate material.

c. General Electric 200-hp electric dynamometer, Model 26-G-283.

d. Inertia System:

Flywheel	18.3 lb-ft^2
Shafts, flanges, universal joints, and coupling	7.9 lb-ft^2
Dynamometer Rotor	90.3 lb-ft^2
Total inertia of the system	116.5 lb-ft^2

e. Torquemeter, 12,000-lb in. capacity.

f. Engine cycling timer and an air cylinder to actuate the throttle.

g. Recording oscillograph to record with time:

(1) Engine rpm.

(2) Transmission output shaft rpm.

(3) Transmission output shaft torque.

(4) Clutch apply pressure.

(5) Main line pressure.

h. Transmission sump fluid cooler circuit containing a pump, 3-way throttling valve, and heat exchanger.

i. Heat exchanger to control the transmission lubrication fluid temperature.

j. Instrumentation for observing the following temperatures:

(1) Transmission lubrication fluid.

(2) Transmission sump fluid.

(3) Engine oil.

(4) Engine water.

k. Instrumentation for observing engine speed and dynamometer speed.

l. Running time meter.

m. Cycle counter.

Preparation:

4. a. Clean all the transmission parts with cleaning solvent.

b. Rebuild the transmission to Chevrolet Shop Manual specifications, using the following new parts:

(1) Type A or B composition faced clutch plates and steel plates.

(2) All seals and gaskets.

(3) Clutch drum thrust washer, low sun gear thrust washer and bushing, low-and-drive valve body, and governor.

(4) All defective parts.

c. Grind 0.050 ± 0.002 in. off the end of

major role in transaxle fluid testing.

the detent valve that the throttle valve lever acts on. The detent valve is modified to obtain a full detent upshift point and a detent touch downshift point using a fixed throttle valve pressure.

d. Install adjustable bracket or rod for securing the throttle valve lever at fixed positions and connect pressure gage to the throttle valve test plug.

e. Install vacuum modulator plunger length adjustor and connect pressure gage to the clutch apply test plug on the low and drive valve body side cover.

f. Install transmission to engine and dynamometer.

Starting Procedure

5. a. Fill transmission with 5 qt of test fluid.

b. Start engine, transmission in neutral, and with the engine idling add another 5½ qt of fluid.

c. Start auxiliary pump and circulate sump fluid through cooling circuit. Add fluid as required (approximately 2 qt).

d. Run transmission in low range ½ hr.

Engine: 1000 rpm
Transmission output shaft: 40 lb-ft

Auxiliary pump is on. Water is turned off to the heat exchangers in the sump and lubrication circuits, unless required. Lubrication-in temperature shall not exceed 140 F.

e. Check transmission fluid level.

Cycling Procedure:

6. a. Place transmission shift lever in drive range.

b. Set cycle start position by adjusting the carburetor idle speed screw and the dynamometer load.

Engine: 450–500 rpm
Transmission output shaft: 40–45 lb-ft

c. Set throttle valve pressure (50–55 psi range) to obtain an upshift peak engine speed of 4100–4150 rpm.

d. Set engine throttle opening and dynamometer speed boost control to obtain an acceleration time of 3.8–4.2 sec, from the cycle start to 4100–4150 engine rpm. At the start of the upshift the transmission output shaft torque is 350–365 lb-ft at 2200–2250 rpm. After the upshift, transmission in direct drive:

Engine: 2650–2775 rpm
Transmission output shaft: 275–290 lb-ft at 2275–2400 rpm

Clutch apply pressure in direct drive is set at 88–90 psi by adjusting the vacuum modulator plunger length.

e. Manually open engine throttle and upshift transmission to check operation.

f. Start cycle, 6 sec open throttle and 6 sec closed throttle. Open lubrication cooling circuit as required.

g. Start cycle timer when sump fluid-out temperature is 175 F and lubrication-in temperature is 130 F. Transmission sump fluid-out temperature, 180 ± 5 F, and lubrication-in temperature, 135 ± 5 F, are maintained constant throughout the test.

h. Check transmission fluid level while idling at operating temperature and correct if required.

i. Record each hour the following:

(1) Time of day.
(2) Running time.
(3) Number of cycles.
(4) Engine rpm at upshift.
(5) Transmission output shaft rpm at upshift.
(6) Dynamometer load at upshift.
(7) Acceleration time from cycle start to the upshift.
(8) Clutch apply pressure after upshift.
(9) Transmission sump fluid-out temperature.
(10) Transmission lubrication fluid-in temperature (max).
(11) Engine oil temperature.
(12) Engine water-out temperature.

j. Record with oscillograph each hour, or at test failure, the information listed in 3g.

k. Check transmission fluid level each 8-hr shift. If low, add as required and record amount.

l. Terminate the test at 5000 cycles or at point of transmission malfunction.

Report:

7. a. Condition of clutch plates.

b. Condition of other transmission parts.

Doppler-Inertial Navigation System for Jet Transports

. . . a guidance system developed for missiles offers accurate flight control information to the pilot of supersonic aircraft.

Excerpts from paper by

L. S. Reel

Ryan Aeronautical Co.

THE DOPPLER-INERTIAL NAVIGATION SYSTEM, now used on missiles and space vehicles, can be adapted to supersonic jet transports. It can supply continuous, automatic, and accurate information on aircraft attitude, ground velocity, present position, distance to destination, and distance to the left or right of desired ground track. Such a system would supply rapidly the up-to-the-minute information needed to navigate high-speed aircraft. A drawback of current navigation systems is the time the pilot takes to calculate his position — on supersonic aircraft, the pilot will not have this time.

Formation and operation of system

A doppler-inertial system is the combination of a set which measures ground velocity by means of the doppler principle with a set which derives ground velocity by means of inertial principles. Each set has its own error characteristics. The first step toward making a doppler-inertial system is to compare the velocity outputs of the two. The difference between the two signals can be treated as an error signal and used to feed corrections back into the system. The fact that the doppler velocity accuracy is independent of time (for times greater than several seconds) permits using the difference to make long term corrections in the inertial velocity outputs. By taking the final system velocity output directly from the acceleration integrator output of the inertial set, the short term, good instantaneous response of the inertial equipment is maintained. The doppler-inertial system does not pass rigid error variations originating in the doppler set. This selectivity in the source of the velocity information means that the combined system inherently provides highly accurate velocity information over all time periods.

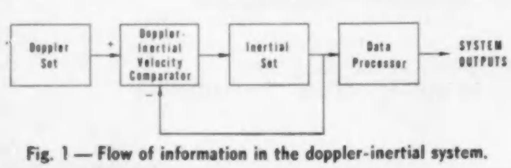


Fig. 1 — Flow of information in the doppler-inertial system.

A diagram indicating the flow of information in the doppler-inertial system is shown in Fig. 1. The blocks represent the doppler set, the doppler-inertial velocity comparator, the inertial set, and the data processor. The doppler and inertially derived velocities undergo comparisons in the doppler-inertial velocity comparator. This latter unit operates upon the difference velocities in a predetermined way and furnishes the resulting feedback error signals to the inertial ground velocity indicator. The primary system outputs appear at the output of the inertial set. A data processor operates upon these outputs to provide necessary derived flight control information.

One of the simplest ways to make corrections in the inertial set is to amplify the difference signal and feed it directly into the inertial set to the appropriate functions. There are two functions within

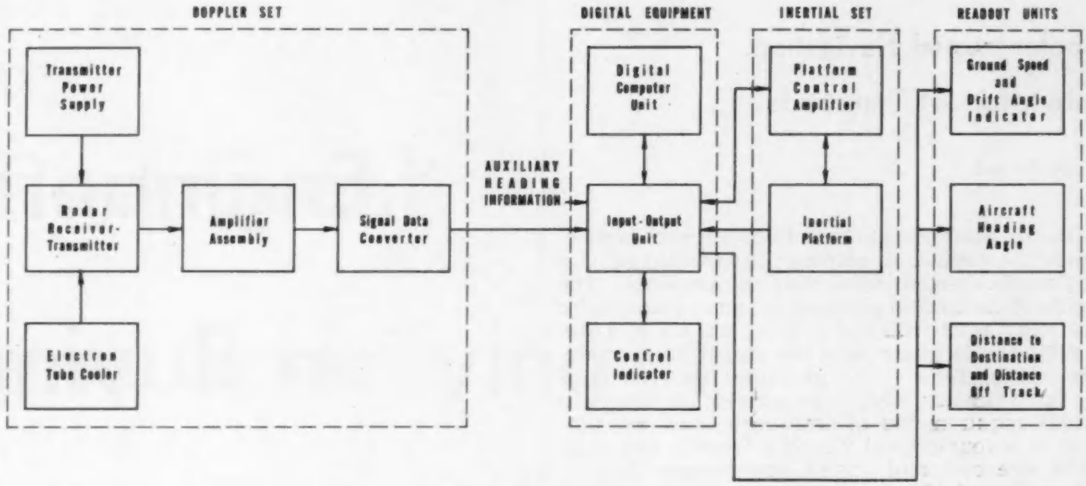


Fig. 2 — Block diagram of the doppler-inertial system adapted for use in a jet transport.

the inertial equipment to which the error signals may be added:

1. The input of the acceleration integrator where, upon integration, it makes a direct correction in the inertial velocity output. The integrator itself provides averaging of the error signal, which includes doppler signal components.
2. The precession signals for the platform, which compensate for gyroscope drift and accelerometer errors. This compensation results in a direct correction of platform vertical errors and indirect correction of inertial velocity errors.

In the resulting doppler-inertial system, the doppler-derived velocity information provides damping and correcting signals to the inertial set. This technique dampens the amplitude and reduces the period of the error oscillations; in addition, it counteracts the errors which are constant or which are random. The combined system acts as a low-pass filter for velocity errors originating in the doppler set and a high-pass filter for errors originating in the inertial set. This is, therefore, an optimum combination, obtaining the most desirable characteristics of the two sets.

The system furnishes a vertical reference whose accuracy is independent of direct aircraft accelerations and is adequately compensated for accelerations originating in the profile of the earth and Coriolis. This reference is very precise and instantaneously accurate. Aircraft pitch and roll angles derived from this reference are available for use in the autopilot for attitude displays, for computer inputs, and for other equipments which require attitude information. In addition to these features, the inertial equipment includes a degree of freedom in azimuth which is both pitch and roll stabilized. This degree of freedom provides a filter for raw azimuth reference information such as that obtained in an earth's rate directional reference. By making the azimuth gyroscope a high quality component, a large amount of time-averaging is available to the unprocessed azimuth information.

Application to jet transport

The equipments which comprise the doppler-inertial system fall into four categories: doppler, inertial, digital, and readout. Fig. 2 presents a block diagram of a doppler-inertial system suitable for use in a jet transport. The doppler equipment consists of five basic units: a radar receiver-transmitter, a transmitter power supply, an electron tube cooler, an amplifier assembly, and a signal data converter. The radar receiver-transmitter contains a klystron power oscillator, a transmitting and receiving antenna function, and crystal detectors. The outputs of the radar receiver-transmitter are low level audio signals — the doppler signals. The amplifier assembly raises the level of these doppler frequencies and provides them as inputs to the signal data converter.

The signal data converter changes the audio frequencies into digital pulse trains whose numerical values are proportional to the doppler frequencies. The transmitter power and the size of the antenna are selected to be as small as possible but to be compatible with the altitude and accuracy requirements of the flight control data for the jet transport.

The inertial equipment contains two units — an inertial platform and a platform control amplifier. Circuits included in the platform control amplifier

Doppler-Inertial Navigation System for Jet Transports

. . . continued

isolate the platform gimbals from aircraft motion, process the gimbals in response to external signals, and provide accelerometer restoring currents. The outputs of the inertial platform are analog signals for the aircraft pitch, roll and azimuth angles, and digital pulse trains whose rates are proportional to aircraft accelerations. The platform itself contains only three gimbals, which are sufficient to cover the attitude requirements of transports, and, as compared to a four-gimbal platform, reduce the complexity, size, cost, and weight, and increase the reliability of the platform.

The digital equipment is made up of a small, special-purpose, airborne digital computer, an input-output unit, and a control indicator. The input-output unit routes signals as required, makes necessary conversions between digital and analog forms, and adjusts scale factors. The digital computer performs a number of operations. These operations include deriving aircraft ground velocity from the doppler frequencies and the pitch and roll inputs from the platform, comparing the doppler and the inertial velocities, computing the necessary error feedback signals, computing signals to control the azimuth gimbal, and generating signals to compensate for the rotation of the earth. In addition to solving the equations for the doppler-inertial system, the capacity of the digital computer may be chosen to perform auxiliary computations—such as great circle course and distance to alternate destination, position data from celestial fixes, and position data from radar or radio aids.

The complement of readout equipment provided for the doppler-inertial system would be tailored to meet the needs of the particular installation. Certain readout devices or their equivalents would be common to all installations. These functions could include an indication of aircraft ground speed, drift angle, aircraft heading angle, distance to destination, and distance to the left or right of desired ground track.

In addition to the conventional readout equipment, the advent of supersonic jet transports will probably be accompanied by some new readout equipment. One such device which may be useful is a position predictor, which informs the pilot what his position and altitude will be at any desired time in the future based upon present flight conditions.

Another type of readout equipment would display wind magnitude and direction. Wind information could be recorded continuously along the flight path to furnish accurate wind information for use in planning subsequent flights.

To Order Paper No. 111V . . .
. . . on which this article is based, turn to page 6.

Engineers' in Buying

Based on panel secretary's report by

E. E. Bryant
Nelson Muffler Co.

ENGINEERS play the dominant part in saying what parts and materials shall be used in the products which they design. And they often play an important part in deciding where those parts and materials shall be bought.

These engineering influences on purchasing are implemented in different ways in different organizations, but common to a majority of automotive plants are the following:

1. Engineering puts into writing (by way of blueprints, standards, or even pictures) everything it can — whether the buying is to be done by the purchasing department or by a purchasing group of the engineering department.
2. Engineering works more directly with supply sources in the case of parts or materials where exact buying specs can't readily be put into writing.
3. The purchasing department is usually responsible for designating "qualified" sources — whether or not engineering is dealing direct in a particular case.

   Close running communication between engineering and purchasing takes place on an informal as well as a formal basis. Rarely does either purchasing or engineering try to dominate.

How one truck company buys

At one large truck company, for example, engineering's participation in the procurement area varies as to whether the units sought are proprietary assemblies (axles, transmission, brakes, etc.); specialty items (metals, vinyl, paint, etc.); fabrications (stamping, forgings, castings, etc.); or standard parts (like bearings, screws, wire, etc.).

Part Great and Specifying

The process of selecting a proprietary assembly — which is often patented or contains patented features — starts, at this company, with a request by engineering to various vendors for design, cost, and performance information.

Usually timing or budget considerations dictate limiting installation design and performance and endurance testing to one — or at most two — of the proposals submitted. So, a preliminary decision has to be made, eliminating some of the proposals. To make this decision, engineering assembles data on costs, installation problems, predicted performance and durability, competitive usage, marketability, service, legal influences, manufacturing complications, and concurrence with long-range planning.

After the preliminary decision, the remaining one or two proposals are subjected to thorough laboratory and proving ground test programs to confirm the selection. At this point, engineering usually works closely with the supplier of the assembly — and design modifications often result.

The **specialty items** are frequently "materials." They are purchased by trade name or by an engineering standard tailored to the properties of the desired material. Frequently engineering will test and approve material from only one source — which restricts purchases to that source. New applications of specialty items are always initiated by engineering. Generally, the engineers get their information from an advertisement in a technical journal or from a well-timed sales call. In either case, the application is tested and approved by engineering . . . and the properties covered by an engineering material standard.

As regards **Fabrications,** the vendor usually offers only the ability to make the part accurately, economically, and on time. That means that many sources are available, and engineering's part — aside from the usual tests — is chiefly that of assisting purchasing in source approvals.

Engineering's part in procurement of standard parts — like bearings, screws, etc. — is primarily to provide the engineering material standards and drawings to hold the quality of the part within acceptable limits. Actual purchase is established largely by price and service factors.

Engineering's basic responsibilities

Engineering in almost all companies is recognized as responsible for supplying the purchasing group with data necessary to permit buying at lowest cost or greatest value. With SAE standards furnishing a big assist, much of this information can often be given on engineering drawings . . . in the form of dimensions, finishes, materials, heat treatment, and physical properties. In such cases, purchasing departments tend to feel it their right to buy wherever they see fit.

But when it comes to items where desired performance characteristics can't be stipulated satisfactorily in detailed design specifications, the right of engineering to restrict possible sources tends to be accepted by all concerned.

Tractor company practice

Typical of areas where one large tractor company feels it impossible to spell out requirements in complete and exact technical language are these:

1. Complete assemblies, such as engines, transmissions, clutches, radiators, etc. These assemblies are usually selected by engineering from both laboratory and field tests on prototype items.

2. More or less proprietary materials, such as friction materials, plastics, gasket materials, seat materials, etc. Usually these are handled in the same way as purchased assemblies.

3. Certain quality tolerances also defy exact definition . . . such as nicks, scratches, and other irregularities on finely finished parts; permissible amount and location of porosity in castings; permissible

Engineers' Part Great in Buying and Specifying

. . . continued

seams in bar stock, etc. (It is now common practice in this one company to show on the drawings of bevel gears a picture of the permissible variation in the location and the area of contact between the gear and the pinion . . . and this same pictorial approach is being recommended as the best solution to other quality tolerances . . . This procedure saves much time and argument involving engineering, purchasing, inspection, and vendors . . . who, at an original conference, have agreed upon the limits and recorded their agreement in photographs or drawings which become a part of the permanent record.)

In the case of these hard-to-write-down-specifications cases, the engineering department of one large ground vehicle manufacturer regularly takes six specific steps, as follows:

1. Consults with purchasing on selection of vendors *before* tests are started.
2. Holds joint discussions with both purchasing and selected vendors *before* tests are started.
3. Nails down on drawings as completely as possible the performance, durability, quality, and material specifications of the item.
4. Tests more than one vendor's product to put purchasing in a good bargaining position and to provide alternate sources where practical.
5. Continuously tests for performance and durability after production has started, with reports to purchasing. Purpose: so engineering and purchasing jointly can keep vendor on the beam and permit the making of any changes indicated necessary as result of field experience.
6. Works continuously with purchasing and vendor on cost reduction of the assembly, including additional testing where required.

In the selection of suppliers for experimental pieces, engineering tends to play the most important part. But it is usual for purchasing to supply a list of "qualified" sources from which engineering would be expected to work. In supplying such "qualified" lists, however, purchasing is notably careful to keep the way open for entirely new sources. As one major purchasing agent describes his own operations: "purchasing makes no attempt to restrict engineering's contact with any supplier or potential supplier. Our only requirement is that a purchasing representative sit in on the original contact and be kept acquainted with subsequent discussions so that we know of the progress that is being made.

"We prefer that suppliers, with whom we have not done business before, contact purchasing before engineering. Then we can get proper information and data about the facilities of the company. Actually, this procedure insures contact with our engineers. It is mandatory in our company that, when a purchasing representative is contacted, the product be brought to the attention of the proper product engineer. The purchasing representative is not permitted to make the decision as to whether or not we are interested in the product."

Practices in one large automobile company emphasize the vital part engineering plays in source selection when unit is to result from a cooperative development program with the vendor — which is the case in a great many of the most important technical developments in the automotive industries.

These cooperative programs usually start with a novel idea in the mind of some vendor engineer — or, it may be an idea of a car company engineer which needs further development to be made applicable.

In such cases, the car company and vendor engineering staffs jointly do the design and test work necessary to conclude the project . . . and purchasing is kept advised of the scope of the vendor's contribution. If the vendor's development work is paid for by the car company — as is sometimes the case — the developed unit may be purchased by competitive inquiry. Often, however, the vendor contributes his share without being paid for his development effort. Then, he is given an advantage when it comes to actually buying the item or material. Besides, he obviously has an inherent competitive edge through his familiarity with the project — and is assured of being one of the sources queried.

In one large vehicle company, the engineering department has its own purchasing department which works with approved lists of suppliers made available from the company's central purchasing department . . . on procurement of non-critical parts.

On critical items, product engineering itself negotiates with potential suppliers, helped as required by central purchasing, patent, and law departments.

Engineering and purchasing, it is usually believed, must be separate departments because they have many responsibilities which they do not share and many skills which are not common.

But, it is equally agreed among engineers and purchasing agents, each group must exercise its influence from the time an engineering need arises until the product is delivered. To insure that effective application of both influences is constant, clear communciation is a vital need. As one executive expresses it:

"To get effective operation and maintain good interdepartment relationships, there must be an understanding of individual responsibilities. There must also be a network of understanding and confidence between the departments. Yet, the same relationship must be maintained with current and potential sources of supply."

"Improve your communciations!"

Serving on the panel which developed the information on which this article is based, in addition to the panel secretary, were: chairman, **C. T. O'Harrow**, Ford Tractor & Implement Co.; **S. C. Bielwaski**, Allis-Chalmers Mfg. Co.; **W. W. Henning**, International Harvester Co.; **T. A. Haller**, J. I. Case Co.; and **I. R. Kappler**, Ford Tractor & Implement Co.

(This article is based on a report of one of nine production panels on farm, construction and industrial machinery subjects. All nine reports are available as a package as **SP-328**. See order blank on p. 6.)

Sandwich Sheets are Now Produced at 50 sq ft per min

Based on paper by

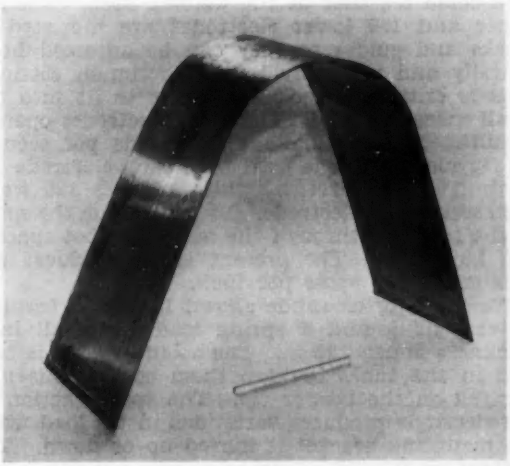
J. W. Scheuch

North American Aviation, Inc.

MASS-PRODUCED SANDWICH material promises to be competitive, cost-wise, with conventional structures, according to North American Aviation. The success of a pilot program brought about an all-welded stainless-steel sandwich 30 in. wide, at a fabrication rate of 50 sq ft per min. Further, the sandwich can be contour formed during production as well as run off in flat sheet.

This is possible because of two final production machines, a 5-in. 65-row core machine and a 385-row welder. These are backed up with a rewrap machine for the coiled facing sheets and an automatic cutoff shear.

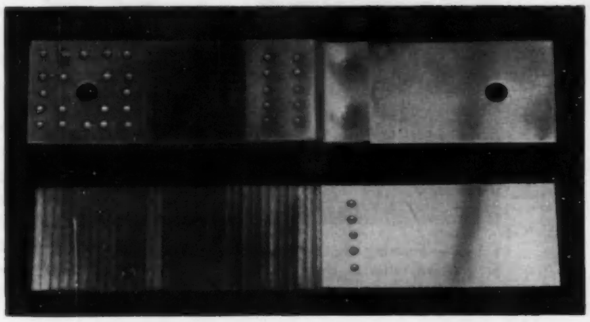
The high-temperature sandwich, or "Spacemetal," is 11/64 in. thick and is made from SAE 30 301 stainless steel. The core is half hard with beaded sides for additional flatwise compressive



Fabrication for parts

Two techniques can be used to form the sandwich into parts. They are:

- Stretching a cover sheet to produce curved panels with a radius as low as 9.5 in.
- Transferring the load in the sheet to other parts by spotwelding, riveting, bolting, or fusion welding.



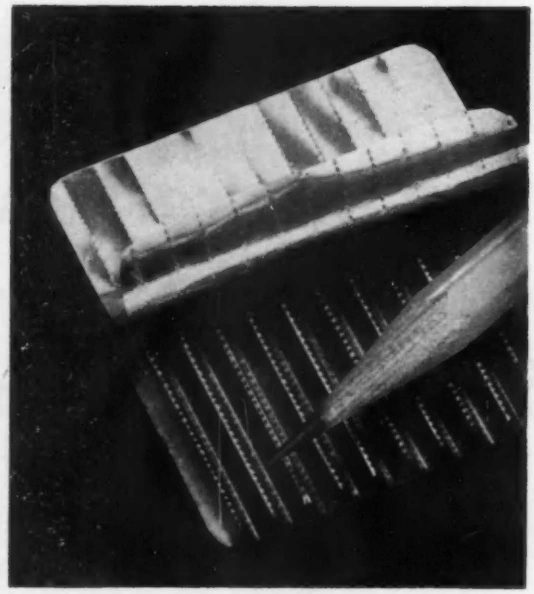


Fig. 1 — Mass-produced sandwich construction can now be formed in sheets 30 in. wide.

Sandwich Sheets are Now Produced at 50 sq ft per min

. . . continued

strength; its height and pitch are 5/32 and the crests are flat to give room to spotweld to the facing sheets. The cove is formed from 0.002 stock. The facing sheets are 0.006 stock, full hard temper. Fig. 1 shows a pealed back sample.

Core machine

A Yoder roll forming machine was modified to fit the project (see Fig. 2). The machine forms a 5-in. wide, 65-row strip of core at a rate of 25 fpm. The decision to fabricate narrow strips resulted from the fact that a full core requires stock 70-in. wide or three times the width available from steel suppliers. Also, the core machine itself would have to be 50-ft long with approximately 60 folding stations to accommodate a full core.

The flat stock is first trimmed to 11¾ in., then beaded while still flat and finally folded through 13 progressive rolls. The core is stored on large drums that hold six coils. This drum later feeds the welding machine with 30 in. of core for the final sandwich.

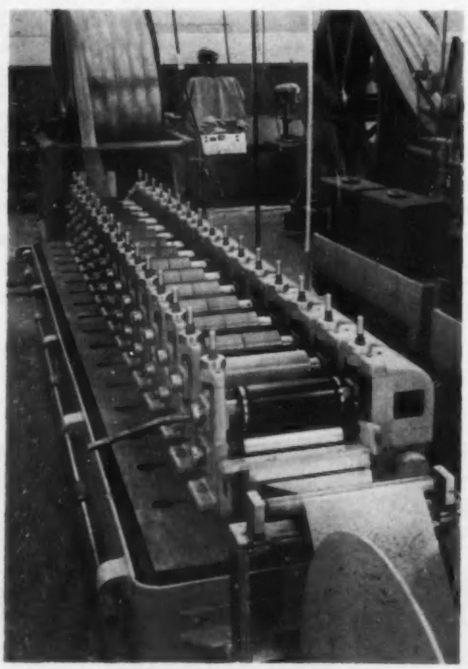


Fig. 2 — Forming the core for the sandwich requires 13 progressive rollers. Only 1/6 of the core is produced at one time to keep down the size of the roll forming machine.

Welder

A schematic of the 30-in. welder is shown in Fig. 3. The six strips of core are fed through an interfold station where outer corregations of adjacent core strips are overlapped. Consequently at five places across the sandwich, there is a double thickness of core. The facing sheets are fed from reels above and below the welder. Facing sheets and core come together at the welding area. The 193 upper and 192 lower electrodes are mounted in blocks and guides so they can be adjusted horizontally and vertically to give optimum settings. This is critical if the electrode is to fit into the small space provided. These 385 electrodes operate simultaneously to make 46,200 welds per second. Half-cycle welding is used with each electrode receiving 60-cps current. This produces 120 welds each second per electrode. By controlling the speed of the material through the machine, spot spacing can be varied. The present speed produces approximately 30 spots per inch.

The welding electrode shown in Fig. 4 features water cooling and a spring loaded tip, all in a thickness under 0.15 in. The cooling water is carried in the tubes to keep them cool and is also sprayed on the copper tip. The spring action of the electrode produces variations in tip load when the mounting bracket is moved up or down. The contact tip is made of tungsten wire pressed into a coined boss in the copper.

To Order Paper No. 99V . . .
. . . on which this article is based, turn to page 6.

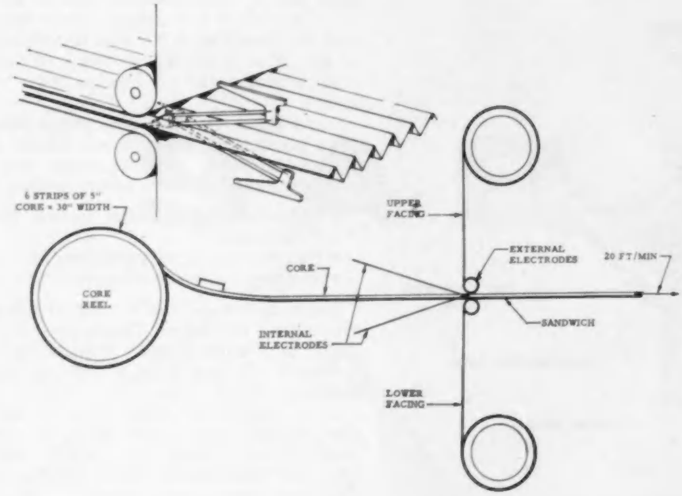


Fig. 3 — Schematic of welder which produces 385 welds at one time. At a sandwich speed of 20 fpm, 46,200 welds are made each second.

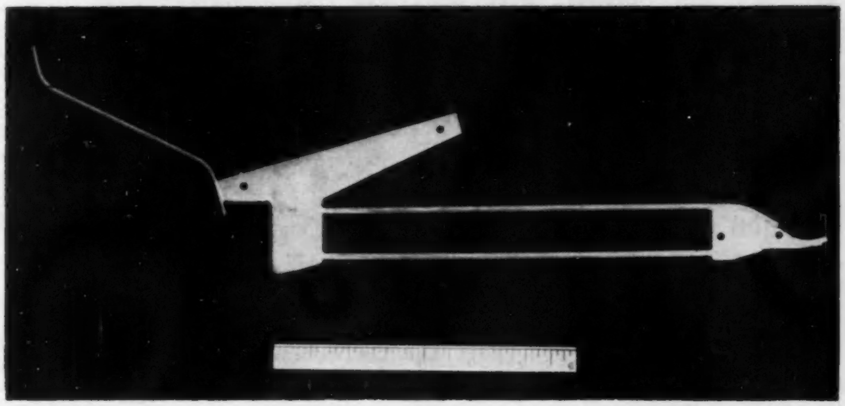
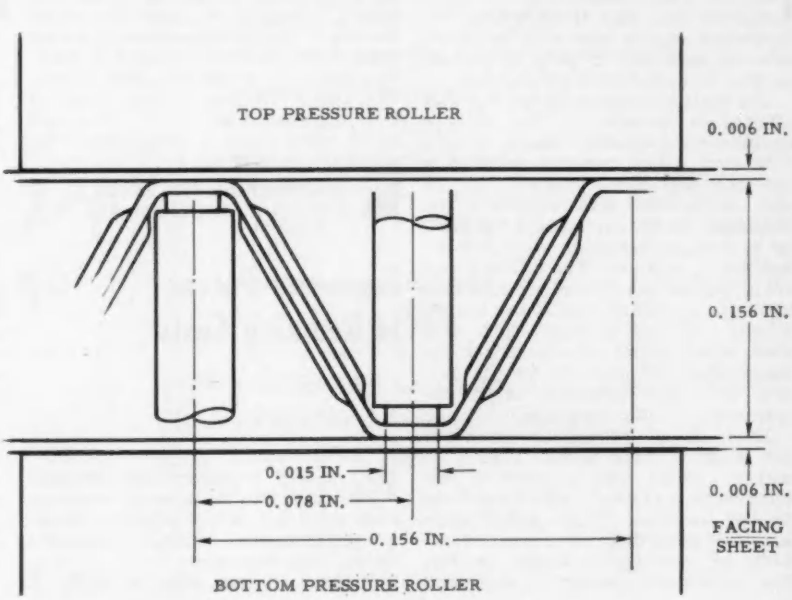


Fig. 4 — Heart of the welder is the very thin electrode. Cooling water is carried through the supporting tubes, and then sprayed onto the tip.



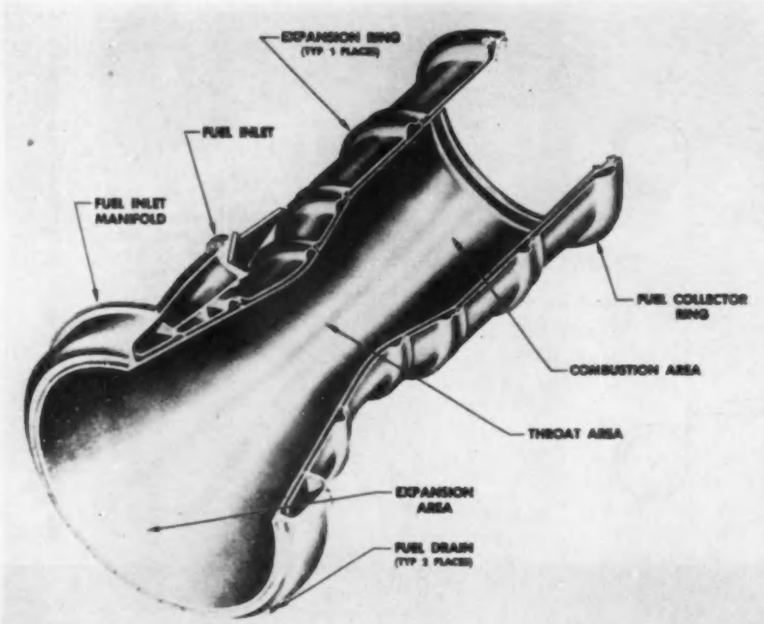


Fig. 1 — Double-wall, regeneratively cooled thrust chamber of the Redstone rocket engine, which is formed from segments of SAE 4130 steel, illustrates use of relatively common materials for high-temperature service.

Common Materials Serve Rocket Engines

Based on paper by

R. P. FROHMBERG

Rocketdyne Division,
North American Aviation, Inc.

THE stringent requirements for rocket engines in high-temperature environment can be met with relatively common materials by good design and careful manufacturing techniques.

The Redstone engine thrust chamber affords an example in that it is a double-walled chamber made of SAE 4130 steel. The material selected in this case was based primarily on the ease of forming and welding. The chamber (illustrated in Fig. 1) is made up by forming segments which are assembled by welding. The welded joints are of highest quality and are subjected to visual, penetrant, and X-ray examination. In this manner, SAE 4130 steel, which is not considered a high-temperature material, serves the purpose by taking advantage of the regenerative cooling principle.

More recent production chambers are made of pure nickel tubes ("A" nickel) which are preformed, assembled on a mandrel, and brazed and banded together. This configuration, although more difficult to produce, results in substantial weight savings. The reduction in weight is equivalent to increased thrust and range and therefore a premium well worth pursuing.

The selection of material for a typical tubular wall thrust chamber such as used in large liquid rocket engines again is predicated on factors other than the material's ability to resist extremely high temperatures. The chamber is made of nickel tubes approximately 0.5 in. in diameter and 0.012 in. wall thickness which are brazed together to form the thrust chamber. Reinforcement bands at the combustion chamber end and at intervals along the nozzle are used to provide added strength. Again, these reinforcing bands are SAE 4130 steel, which never reach a temperature very much in excess of 200 F.

To Order Paper No. 98V . . .
on which this article is based, see p. 6.

Engineers Potent in Reducing Costs

Based on report by secretary

J. F. GINTHER

Allis-Chalmers Mfg. Co.

TOO MANY engineers are cost-conscious only in times of austerity. Cost reduction can be a potent factor in profit-making during prosperous times. For instance:

Suppose an item sells for $100. It costs $80 to manufacture; $10 to sell . . . . leaving a $10 profit. Now, suppose the manufacturing cost is reduced by $5. The profit at the same selling price becomes $15 . . . an increase of 50%!

Reductions of this magnitude are quite possible in many cases, where a well-coordinated cost-reduction program includes three necessary steps:

- Thorough preparation before installation.
- Active training of participants.
- Positive follow-up procedures.

Value analyses, work simplification programs, employee suggestion systems, and management control philosophies all can play a part in effective cost reduction.

Cost reduction, some experts advise, should be started first on the product that is making the least profit. This will help, among other things, to make engineers cost conscious — which is necessary because they can and should be more responsible for cost reduction than anyone else.

"There is a trend," says one important manufacturing executive," toward engineers becoming more responsible for profits. . . . It is entirely possible that organizational structures may have to be changed in the future to accept more fully the idea that engineering is directly related to profits."

Serving on the panel which developed the information in this article, in addition to the panel secretary, were: **T. G. Mercuro,** Allis-Chalmers Mfg. Co., Norwood Works; **Richard Connelley,** A. O. Smith Corp.; **Calvin Henderson,** Hotpoint Division, General Electric Co.; **A. R. Tresselt,** Le Roi Division, Westinghouse Air Brake Co.; and chairman **Allen V. Gaulke,** Allis-Chalmers Mfg. Co.

To Order SP-328 . . .
on which this article is based, see p. 6.

Jet Blast Raises Havoc

Based on paper by

THOMAS M. SULLIVAN

Port of New York Authority

THE high velocity of jet exhaust has required the erection of blast fences, additional paving, and restrictions on engine operation on terminal apron areas at New York International Airport.

A blast fence 12 ft high was installed 75 ft from the end of the pavement of runway 25 to protect vehicular traffic on the adjacent public highway. Since new craft have a tendency to undershoot the landing, and one jet transport clipped the top of the fence, the height of the fence has been cut to 10.5

continued on p. 116

SAE NEWS

1960 Annual Meeting
See p. 98

"SUCCESS and SCHOLARSHIP"

By SAE Past-President **William K. Creson**

SAE PAST-PRESIDENT WILLIAM K. CRESON continues his active interest in the student development projects which played so large a part in his activity as SAE President in 1958. He is serving as Special Advisor to the current chairman of the SAE Student Committee, E. P. White . . . and recently he contributed to his Sigma Alpha Epsilon chapter at Purdue an answers-to-student-questions presentation titled "Success and Scholarship." It was based on his contact with SAE enrolled students and other engineering students in the 53 engineering schools he visited as SAE president.

"Success and Scholarship" reads in part:

Q . . . Why should I make a strong effort for a higher scholastic index?

A . . . Because, until a better method of keeping the score is devised, it is the accepted measure of your accomplishment . . . on a commitment you have already accepted by your very presence at school.

Q . . . Some students make better grades with less effort. Is this fair?

A . . . Yes. It's not only fair, but inevitable. The real question is whether or not you are exercising the full capability of your mental equipment.

Q . . . Can I be a "good student" without loss of prestige, social or otherwise, with my fellow students?

A . . . Certainly. The fact is that a decent scholastic index adds to your prestige in every way.

Q . . . Do you relate the collegiate scholastic index to later success in life?

A . . . I do. All available data strongly supports this opinion. Have a look at "Who's Who." A relatively few examples to the contrary only tend to prove that education can continue throughout life, regardless of age or circumstances, if motivation is present.

Q . . . There are a lot more diverting activities now than when you were in school. Do you think you could cope with them today?

A . . . I wouldn't try to. I would give careful thought to selecting the few in which I would participate and would forget the rest.

Q . . . Why do fraternity chapters seem to follow sine curves cycles of general scholastic index?

A . . . The index is almost always high when the leadership is good, poor when the leadership is weak.

Q . . . Should scholarship be sacrificed for participation in athletics, social or other extra curricular activities?

A . . . It doesn't need to be. The well-rounded man is the best product of a college, and a respectable scholastic index is the number-one mark of such a man.

Q . . . Some students are brilliant, have good memory, absorb knowledge readily, make good grades rather easily. Others do it the hard way. Which kind of student would you rather be?

A . . . We don't have such an option.

SAE LETTERS FROM READERS

From:
Hugh Harvey (M '51)
No. 1 Kingsway
London, W. C. 2, England

Dear Editor:

The November issue of the Journal has just arrived and I have read with great interest Leonard Raymond's article "Cooperation in Research." I am very sorry I did not have the opportunity of hearing him while he was over here, but as I recall I was away on holiday. This article is most interesting because it points out the progress that can be made by cooperation between the oil and automotive industries.

From:
Greg F. Benjock
Ambridge, Pa.

Dear Editor:

I am now a student at the University of Pittsburgh's school of mechanical engineering completing my third year. I have been an active member of the SAE student chapter here at Pitt throughout my college years and continually admire the advancements SAE has made concerning current programs of lectures and engineering displays throughout the Greater Pittsburgh Area.

The SAE Placement Service is one of our greatest features in making the Society enjoy the prestige it now commands. Enclosed, you will find my application slip along with an unwritten vote of thanks and appreciation for all you and SAE have done for Student Branches throughout this nation.

In closing, may I again congratulate you and the Society for the Placement Committee!

From:
R. E. Hanslip (M'56)
Chief Development Engineer
Mather Spring Co.
Toledo, Ohio

Dear Editor:

A recent SAE paper, which described a new truck design, stated that "at curb load the radius rod has *zero rate effect* and *maximum rate effect* at design load." This terminology is a little confusing and subject to misinterpretation. The following explanation may help to clarify the exact meaning of these expressions.

A main spring and a radius rod can be assumed to be two springs connected in parallel, and for such a case, the

continued on p. 82

SAE Dues Increase Being Studied by Board of Directors

• Reasons for proposal were discussed with committee groups during Annual Meeting

REASONS behind a recent SAE Finance Committee proposal to increase SAE dues were exposed to the many committee groups gathered in Detroit during the 1960 Annual Meeting.

1959 SAE President Leonard Raymond, who explained the proposal to many of the groups personally, emphasized that action would not be taken "until members have had an opportunity to understand and appreciate the situation."

No action was taken by the 1959 Council at its Jan. 15 meeting; nor by the first meeting of the new Board of Directors which met the same day. This means that the next opportunity for action will be at the Board of Directors meeting in April.

In his discussion with the various groups at Annual Meeting, 1959 President Raymond said:

My inaugural address last year, part of which was printed in the SAE Roster Issue, stressed long-range financial planning as the key to more stable and growing member services. I stated that our Finance Committee was already doing some intensive long-range financial planning to assure our having the money required to meet our member needs. I might mention that the Finance Committee has been alert for a long time to this growing financial problem.

As a result of its studies our Finance Committee in September proposed to Council a program for stabilizing the Society's finances. Briefly, the proposal now being studied by Council is to increase total membership dues by 20 per cent to offset the present and further increases in the expense of dues-covered member services.

Studies and analyses made by the Finance Committee reveal the inability of member dues income, at present levels, to support those member services which the dues should pay for. In its recent report to Council, the Finance Committee pointed out that the member service area would operate at a deficit this current fiscal year, as it has in the two previous fiscal years.

The members of Council and others who have been made aware of our financial problem have been strongly conscious of the desirability of utilizing all other avenues than a dues increase to attain the financial stability we now lack.

The Finance Committee has shared this feeling and has already explored other possible means of increasing the Society's income, such as charging members registration fees at Meetings or increasing prices of various existing services. None of the alternative methods proves feasible. They cannot provide the additional needed income and, in a few instances, might result, perhaps, in overall reduction rather than an increase in income.

The problem faced by our Society is not unlike that being met by commercial organizations operating in today's economic climate which are caught in a cost-price squeeze. The only way SAE can meet its service responsibility to its members is to keep its operations in dollar-balance so that income covers expense.

SAE buys the services and materials it needs to carry on the Society's work. And, like all other businesses, SAE, too, has had to cope with continuing inflation.

The Society has tried to buck the inflationary tide of increased costs by substantially improving the efficiency of its operations and by seeking ways in which to boost its income. However, expenses have unfortunately been rising at a faster rate than the many economy and income-producing measures put into effect since the last dues increase in 1948.

I believe the following quotation from the Finance Committee's recommendation to Council last September is a pertinent wrap-up of the problem we face:

"To maintain the basic nature of SAE, to permit SAE to go into a new era that is rich in promise technically and economically for the nation, we must insure our financial competence. There are two alternatives possible.

"1. To maintain the present dues structure and cut back basic SAE services.

"2. To increase the dues so as to provide the financial health to take advantage of the opportunities for service that fast-moving technological developments promise us."

In its review of this proposal, Council has called upon the services of other SAE groups for advice and assistance. For instance, the Executive Committees of both the Membership Committee and Sections Committee have been asked to recommend a plan for modification of the dues schedule in the event that a dues increase is agreed upon by Council. Such a report has been received and is being studied by the Council.

It is interesting to note that this report urges emphasis of the following points in bringing this matter to the attention of the membership:

a. During the past few years the income from member dues has not been sufficient to pay for member services. Inflation is the main cause.

b. Member services have been improved materially during the past 11 years, since the last increase in dues.

c. For sound management and reasonable financial security for SAE, income must be increased or member services must be decreased.

d. Prudent economy of operation has postponed as long as practical the inevitable need to adjust for cheaper dollars — by increasing dues.

I have instructed SAE Headquarters staff to make available to any member, upon request, a set of the figures and other pertinent data which have led to this increase proposal.

I can assure you that the action taken by the Directors and Officers will be one which, in their judgment, will be in the best interests of the Society from the standpoint of maintaining sound financial management for operations and more importantly from the standpoint of continuing to provide and improve our needed member services.

YOU'LL . . .

. . . be interested to know . . .

"HUMDINGER" MEETING ATTENDANCE is what SAE's new Rockford-Beloit Section has been reporting . . . which, interpreted, means that attendance at each meeting so far has been considerably more than the Section's recorded membership.

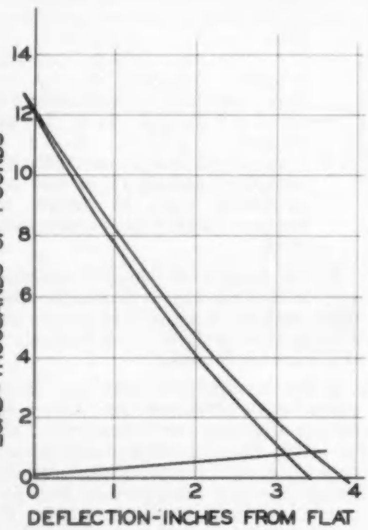
NORMAN S. SMITH, of Pan American World Airways, represented SAE at dedication ceremonies for a new engineering building at the University of Miami recently. He took occasion while there to visit with John D. Gill, faculty advisor for SAE's Student Branch at the University. SAE has had a Student Branch at the University of Miami since June, 1955.

SAE LETTERS FROM READERS

continued from p. 80

combined rate of the spring assembly is merely the sum of the rates of the two springs . . . provided the springs do not come free of their supports. The load in the radius rod may be zero, or directed up or down but the rate is still the sum of the individual rates.

The results of a recent load-deflection test (see accompanying chart) illustrate the effect of the flexible radius rod on a similar suspension. The test



Load-deflection curves for spring on 15-in. radius cams, 46 in. apart.

was made on a spring 3 in. wide, with five leaves of 0.499 in. and five leaves of 0.447 in., and with a three-leaf radius rod. It is supported on cams with a 15-in. radius, 46 in. apart. The test was made with and without the radius rod attached. The upper curve is obtained from the spring with the radius rod disconnected. The lower curve is obtained with the spring and radius rod both connected. At the point where the two-load deflection curves cross, there is zero load in the radius rod. The difference in the ordinates of the two curves at the same deflection is the contribution, or load, of the radius rod. These differences, or loads, are also plotted against deflection and, as can be seen, the resulting curve is very nearly straight. Its slope, or rate, is very close to the calculated rate of the radius rod alone. If we take the slope of the load-deflection curves to be the spring rate, then it is easily observed that the rate of the main spring and radius rod is always greater than that of the main spring alone.

FACTS . . .

from SAE literature.

(Except where a charge is specifically indicated, SAE Journal will be glad to supply on request one copy of any of the pieces of SAE literature described. Address "Literature," SAE Journal, 485 Lexington Ave., New York 17, N. Y.)

"SOUTH POLE CITY," a 30-min, color, sound, 16-mm film is just one of many listed in a recent 4-p. Section-Gram as being available for meetings of SAE Sections, Groups, and Student Branches. A short description of many of the films is included . . . and in all cases there is complete information as to where and how they can be obtained.

"AN IDEA-EXCHANGE CENTER for engineers and scientists" is how the latest Student Enrollment booklet refers to SAE . . . and it tells how the engineering student can participate in and benefit from this "idea-exchange." The booklet is titled *SAE Student Enrollment for Engineering Students.*

SAE NATIONAL MEETINGS

- **March 15–17**
  National Automobile Week, The Sheraton-Cadillac, Detroit, Mich.
- **March 22–24**
  National Production Meeting, Statler Hotel, Cleveland, Ohio
- **April 5–8**
  National Aeronautic Meeting (including production forum and engineering display), Hotel Commodore, New York, N. Y.
- **June 5–10**
  Summer Meeting, Edgewater Beach Hotel, Chicago, Ill.
- **August 16–19**
  National West Coast Meeting, Jack Tar Hotel, San Francisco, Calif.
- **September 12–15**
  National Farm, Construction and Industrial Machinery Meeting (including production forum and engineering display), Milwaukee Auditorium, Milwaukee, Wis.
- **October 10–14**
  National Aeronautic Meeting (including manufacturing forum and engineering display), The Ambassador, Los Angeles, Calif.
- **October 25–27**
  National Transportation Meeting, Hotel Leamington, Minneapolis, Minn.
- **October 31–November 2**
  National Powerplant Meeting, Hotel Cleveland, Cleveland, Ohio
- **November 3–4**
  National Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

SAE's CEP NEWS

COOPERATIVE ENGINEERING PROGRAM

Equipment Expert Heads General Standards Council

Brown

Dall

E. C. BROWN, chief engineer of Austin-Western's Construction Equipment Division, has been appointed chairman of the Technical Board's General Standards Council by 1959 Board Chairman Ralph Isbrandt. He succeeds Milton J. Kittler, executive vice president, Holley Carburetor Co.

With 38 years of engineering experience, Brown has witnessed or instigated many firsts in the development of road building and construction equipment. Among these are: A rear engine power grader, an anti-friction bearing jaw crusher, a diesel-engine-driven motor grader, and the application of hydraulics to road building machinery. During his 24-year affiliation with Austin-Western, he either aided in or directed a continuing evolution of road building and construction machinery and equipment.

As chairman of the General Standards Council, Brown will, along with other Council members, review the technical reports prepared and up-dated by Council committees. These reports will directly affect the production of bearings, parts, and fittings, screw threads, springs, and surface finishes of materials, as well as SAE automotive drafting standards.

The newest member of the General Standards Council is **ALBERT H. DALL**, chief engineer of Cincinnati Milling Machine Company's Machine Tool Division. Dall's engineering career began when he joined Cincinnati Milling Machine Company as a draftsman and designer. Later, his work revolved around standards, then research. From 1951 to 1958, he directed standard machine tool engineering until assuming his current post.

George McCain, retiring chairman of the Involute Splines, Serration and Inspection Subcommittee, received a personal token of the Subcommittee's appreciation of his untiring efforts to bring about a complete overhaul of the SAE Standard on Involute Splines, Serrations, and Inspection. At a Detroit meeting held January 14, McCain was presented with a silver platter by General Standards Council Sponsor Clayton Lewis (right).

Bowers

Cunningham

Davidson

Edsall

Garcina

Gurski

Jameson

Janeway

19 Engineers Awarded

"VITAL to the U. S. free enterprise system" is how 1959 Technical Board Chairman Ralph Isbrandt views the technical committee work of 19 engineers who received SAE Certificates of Appreciation at a Technical Board luncheon held during Annual Meeting. Cited by Isbrandt for unique contributions made to Technical Board committees, the 19 honor guests were presented with Certificates by 1959 SAE President Leonard Raymond.

RAYMON BOWERS was praised for his part in developing the SAE Agricultural Tractor Test Code, an SAE Handbook report which has received international acceptance. During World War II, he was a member of the SAE Tractor War Emergency Committee, a group set up to solve tractor fuel problems. Since then, he has been active in both the Tractor Technical Committee and Tractor and Farm Machinery Activity Committee.

E. N. CUNNINGHAM has generated great interest in the cooperative resolution of elastic seal problems. As chairman of Committee G-4, Elastic Seals, since its inception *and* of its predecessor, he directed the development of a document which now serves as a key to elastic seal sizes. The report, ARP 568, Uniform Dash Numbering System for O-Rings, is currently in broad use by industry.

While **TREVOR DAVIDSON** was chairman of the Construction and Industrial Machinery Technical Committee in 1956, 69 separate committee and subcommittee meetings took place. A CIMTC member for more than a decade, he contributed heavily to the development of SAE test codes for determining reserve tractive ability and vehicle drag of various self-propelled construction equipment. Besides this, he has served as an outstanding member of the Technical Board.

LINN EDSALL, as a member on the Radio Communications Suitable for Automotive Fleet Applications Subcommittee, played a vital role in developing an SAE manual on the installation, operation, and maintenance of mobile radios for use by fleet operators. From 1945 to 1949, he was chairman of another Transportation and Maintenance Technical Committee group which developed SAE power take-off ratings.

For 13 years, **G. M. GARCINA** has been a project sponsor on Committee E-25, Engine and Propeller Standard Utility Parts, an SAE group which prepares military standards for the Air Force and Navy Bureau of Weapons. Besides this, he has worked on many important drafting projects as a member of Committee S-1, Aeronautical Drafting Manual.

JOSEPH GURSKI'S ability to unify technical committee opinion has been demonstrated in many SAE ground vehicle materials groups. The former chairman of the Iron and Steel Technical Committee, Nonferrous Metals Committee, and of ISTC's panel C — Automotive, he has been active in five different ISTC divisions. Currently, he is on the ISTC's Executive Committee.

A well-known leader in the development of SAE fasteners specifications, **A. S. JAMESON** served as chairman of ISTC Panel D — Tractor and Earthmoving and Division 29 — Threaded Fasteners. Jameson has been a Division 29 member for over a decade as well as active in ISTC hardenability, bearing steel, and tool and die steel divisions.

When **R. N. JANEWAY** was chairman of the Riding Comfort Research Committee, a significant ride and vibration report evolved which includes

Johnson

Lamb

Miller

Pickard

Rendel

SAE Certificates of Appreciation

comfort limits or "Janeway curves." His unique contributions toward the attainment of riding comfort are currently being applied to a study of truck ride characteristics.

A. L. JOHNSON, who serves as technical consultant to Minnesota regulatory authorities, has participated in Lighting Committee work for many years, making available his experience with field problems coincident with the use of lighting equipment and safety inspections of such equipment by States. He has been chairman of the Lighting Inspection Code Subcommittee and Headlamp Testing Machine Subcommittee. Recently, he has led these groups in work connected with the four-lamp headlighting system.

E. P. LAMB's understanding of interacting industry and government problems helped the Truck and Bus Technical Committee come up with a fuel tank report which gained acceptance by industry and government alike. In addition, he sponsored a truck performance study for the Transportation and Maintenance Technical Committee which formed a part of the SAE report on Truck Ability Prediction Procedures.

A leader in the development of widely accepted SAE Aeronautical Material Specifications for elastomers, **C. M. MILLER** headed the Nonmetallic Materials Committee of the AMS Division for six years. As a cordinator of several round-robin tests on low-temperature elastomers, he provided much needed background information for the up-dating of AMS specifications.

E. C. PICKARD instigated the formation of the Body Engineering Committee's Seating Subcommittee ten years ago. While chairman of this group, the first SAE Seating Manual was issued, then expanded and further refined into a unique SAE document.

As a Fuels and Lubricants Technical Committee member, **T. B. RENDEL** has been instrumental in bringing together views of the petroleum and automotive industries. One outstanding achievement has been the development of lines of communication between SAE and CRC. As chairman of CRC's Coordinating Committee, he has represented SAE in many activities, including CRC coordination with the Fifth World Petroleum Congress. In addition he has acted in a liaison capacity to SAE aviation groups.

W. C. SCHULTE, the 1959 Acting Chairman of the Aeronautical Material Specifications Division, has broadened the usage of AMS throughout the U. S. and Western Europe. During his many years as an AMS Division member, he helped guide policy related to specification development needs. Since 1952, he has been chairman of the Finishes, Process and Fluids Commodity Committee.

For 13 years, **D. H. SECORD** has distinguished himself as a member of Committee E-25, Engine and Propeller-Standard Utility Parts. Currently, he is chairman of E-25's High Temperature Self-Locking Nut Subcommittee. His knowledge of propulsion hardware was an important factor behind E-25's being cited by the Aircraft Industries Association in its booklet, "Mr. Taxpayer Gets a Break."

F. P. TISCH has been an SAE Screw Threads Committee member since 1947 when SAE, ASA, and the Military Services were working on a unified thread standard which was eventually adopted by the U. S., Britain and Canada in 1948. He went on to become chairman of ASA Sectional Committee B1 for Screw Threads and has since worked to extend the usage of the Unified thread throughout the threaded fastener industry.

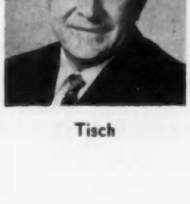
R. P. TROWBRIDGE has occupied many SAE posts and represented the Society on committees of other organizations. For example, the Parts and Fittings Committee assumed new vitality when he became chairman in 1955. Since then, this group has tripled its output. Trowbridge has served as vice chairman of the Aero-Auto Drafting Manual Committee since its inception, and represented SAE on the ASA Graphic Standards Board and the ASA Military Standard Drawing Practice Committee. Six months ago, he became a member of the General Standards Council of the SAE Technical Board.

From 1948 to 1951 when he became chairman of the ASTM-SAE Technical Committee on Automotive Rubber, **DR. H. A. WINKELMANN** led Section 4, a group which maintains what has been described as the basic materials classification document of the rubber and automotive industries. These documents include SAE 10R, Specification for Elastomer Compounds for Automotive Applications, SAE 17R, Latex Foam Rubbers, and SAE 18R, Sponge and Expanded Cellular Rubber Products.

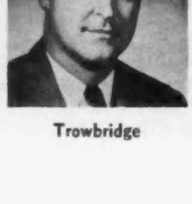
A. H. WINKLER has been chairman of the Carburetor Air Horn and Flange Subcommittee of the Engine Committee since it was organized in 1949. Since then, the Subcommittee has expanded standards coverage on carburetor air flanges and mountings and provided invaluable assistance to the Small Air-Cooled Gasoline Engine Subcommittee. Thus, standardization of carburetor mountings in an area where manufacturers of prime equipment formerly had little common ground has become possible.

Schulte

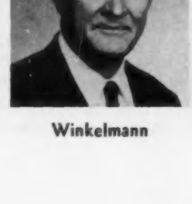
Secord



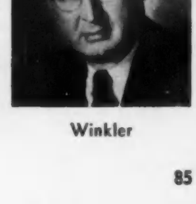
Tisch



Trowbridge



Winkelmann



Winkler

Dr. Andrew A. Kucher

1960 Chairman of SAE Technical

DR. ANDREW A. KUCHER, chairman of the SAE Technical Board for 1960, is vice-president — Engineering and Research of Ford Motor Co. He was elected to this position in April, 1957.

During a career which began in 1916 when he was only 18, he has moved from aviation to refrigeration, back to aviation, and finally into the automotive field. He holds patents on nearly 100 inventions and industrial processes.

Kucher has always had a pioneer outlook.

Airplanes were a novelty in 1906, when 8-year-old Andy Kucher started building models by the dozens, attracting attention among teachers and fellow pupils alike. Soon the local school board had him making trips to other schools in the area to show his model planes and tell how he made them.

When it came time for higher-than-elementary studies, he chose Dickinson Industrial in Jersey City, the nation's first public high school to offer a complete engineering course. There were studies in physics, chemistry, metallurgy and mathematics. Also, there were excellent shop facilities, full courses in designing, pattern making, metal working, and all kinds of machine work.

Directly out of high school, with a solid grounding in engineering, Kucher began to build his own airplane. From meager earnings as an aviation draftsman and designer, he scraped together enough money for materials . . . and even acquired a motorcycle racing engine for the plane's power plant. In this project, he pioneered one of the first planes built with a monocock fuselage, a construction which utilizes the covering of the fuselage for structural support.

The plane took shape in what probably was the strangest place any airplane ever has been built — the loft of an undertaking establishment, surrounded by caskets. It made several successful flights in the New York area but, despite the help of an RAF pilot fresh from World War I, the project never got off the ground financially.

In the war's aftermath, young Kucher was engaged as a draftsman for a refrigeration firm. Soon, he became chief draftsman. Then, in the early 1920's he was consulting engineer for Westinghouse Electric and Manu-

As the SAE Technical Board faces a new decade . . .

THE SAE Technical Board is better equipped that ever to meet the changing cooperative engineering needs of this and future decades. Its recently streamlined structure has already precipitated a re-evaluation of existing and potential services to industry.

Some current aims are:

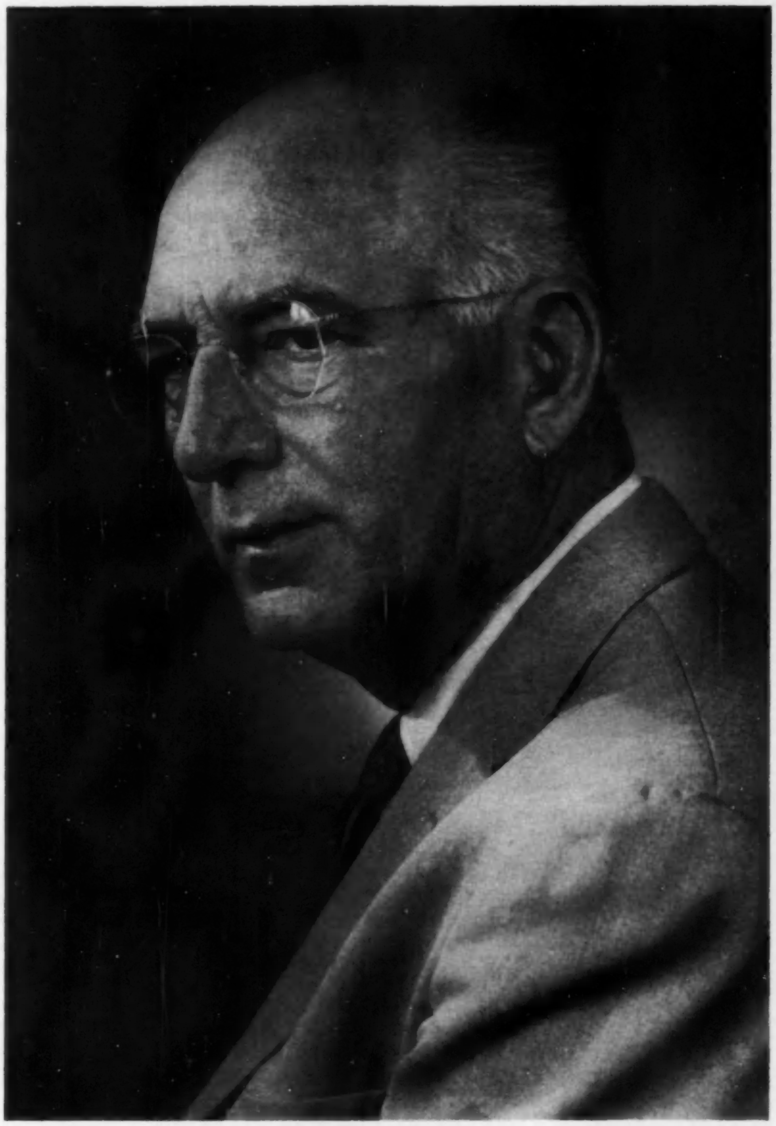
- **Integrating the activities of its aero-space and ground vehicle groups into a more unified operation.**
- **Greater participation in international standardization efforts.**
- **As technological advances thrust new problems onto the national scene, maintaining safety in the automotive industry.**
- **Cultivating important SAE relationships with other technical groups such as the American Standards Association, Automobile Manufacturers Association, Aero-Space Industries Association, Coordinating Research Council, government agencies, and others.**

This is the first of three profiles covering the chairmen of the three SAE boards under whose leadership much of the Society's work is now proceeding.

In the March issue of SAE Journal, a profile of H. F. Barr, chairman of SAE's new Engineering Activity Board, will appear.

In the April issue, a profile of William F. Ford, chairman of the SAE Sections Board, will appear.

Board



Dr. Andrew A. Kucher

facturing Company. But the aviation lure tempted him again.

With enough money to operate, he launched his own airplane manufacturing company and began designing an experimental dual control monocoupe especially suited for training purposes. Everything was moving smoothly — but the '29 crash was on its way. Dr. Kucher relates it:

"I was so busy in my laboratory and workshop, I didn't pay any attention to the signs. One day someone said there was a run on all the banks. I just kept on working . . . and when I looked up I was wiped out."

The beginning of the great depression marked the end of his aviation venture. He returned to the refrigeration business and, in 1931, joined Frigidaire. There he perfected the heremetically sealed household refrigeration unit introduced as the "metermiser." The sealed motor-compressor unit now is universally used in refrigerators and air conditioning machines. He also invented one of the first all-fresh-air conditioning systems.

In 1942, Dr. Kucher moved to Bendix Aviation Corp. As director of research for Bendix, he pioneered additional aviation developments, adding more patents on techniques and devices to his growing store. Within two years he was named a Bendix vice-president.

Ford's new approach to scientific progress began with Dr. Kucher's arrival in 1951. In the years that followed, he built the Scientific Laboratory to a staff of almost 200 persons, 40 of whom were Ph.D.'s, doing fundamental research in physics, chemistry, metallurgy, and electronics. Today, the Laboratory enjoys a scientific reputation parallel with those of the great centers of learning throughout the world.

In the applied research area, Dr. Kucher has exploited an imaginative idea that occurred to him 30 years earlier while experimenting with aerodynamic models. Under his direction, Ford engineers have developed a vehicle without wheels which is supported a fraction of an inch off the ground by air pressure released through "levapads" beneath the vehicle. (See next month's issue of SAE Journal.)

The Lavacar is still in an experimental stage, but holds potentials of providing a new mode of public ground transportation. Projected to its ultimate development, multi-passenger cars could one day be gliding between major cities on an air film, guided by rails and traveling at speeds in the 200- to 500-mph. range.

Although his formal education ended with graduation from Dickinson Industrial high school, the University of Michigan recognized his keen knowledge of the branches of science by awarding him an honorary doctor of engineering degree in 1954. Another honorary degree was accorded him in 1959 by Michigan College of Mining and Technology.

Dr. Kucher lives with his wife at 20520 Audette, Dearborn. Their ranch-type home is only a five-minute drive from his office and, as might be expected, his basement workshop is fully equipped. He builds model airplanes for his grandson, and continues experiments with other types of flying vehicles based upon aerodynamic design concepts he has nurtured for years.

Dr. Kucher is a member of the SAE board of directors for 1960. He also is a member of the board of trustees of the Rackham Engineering Foundation, of the board of directors of the development council of the University of Michigan, and of the board of trustees of Cranbrook Institute.

Technical Board Councils

Carl L. Sadler
Chairman
Aero-Space Council

AERO-SPACE COUNCIL . . . The new decade will throw Aero-Space Council committees into many new areas. Their current activities indicate that there will be greater emphasis on:

- Man's ability to survive physiologically and psychologically in outer space.
- Reliability and check-out, especially for missiles.
- The systems concept over consideration of the single component.
- Shortening the lag between engineering advances and their ultimate utilization.
- Ground training techniques.
- Exotic materials.
- Refining ground support equipment.
- Producing needed new standards at a faster rate.
- Strengthening ties with industry through trade associations such as the Air Transport Association and the Aero-Space Industries Association.

G. J. Huebner, Jr.
Chairman
Automotive Council

AUTOMOTIVE COUNCIL . . . A glance back over the '50s reveals many standardization feats achieved by the 16 ground vehicle technical committees of the Automotive Council. Among these are SAE Handbook reports on the measurement of truck noise, truck ability prediction procedures, radio noise suppressors, motor vehicle seat belts, and brake lining quality control. In addition, test codes were set up for lube oil filters, car and truck automatic transmissions, hydrodynamic drives, and 1000-rpm power take-offs for farm tractors.

Likely to receive committee attention in the '60s are developments related to transaxles, transistorized ignition systems, and integrated hydraulic power techniques.

Muir L. Frey
Chairman
General Materials Council

GENERAL MATERIALS COUNCIL . . . The three most *used* parts of the SAE Handbook are the ferrous, nonferrous, and nonmetallic materials sections, according to an SAE-conducted survey of 1959 Handbook subscribers. Numbering over 100, the reports which make up these sections emanate from the General Materials Council's four ground vehicle technical committees.

As the use of new and existing materials grows, so will the services of General Materials Council groups. In the future, information development is expected on:

- High-temperature ferrous materials, an area heretofore considered the domain of aircraft.
- Performance of lubricants with consolidated functions.
- Plastics and special purpose materials.
- More exact correlation between laboratory and field experience.

E. C. Brown
Chairman
General Standards Council

GENERAL STANDARDS COUNCIL . . . An indisputable way of curbing the cost of high-volume production hardware is to reduce multiplicity of sizes. The committees of the General Standards Council are doing just that through their standardization of nuts, bolts, washers, bearings, pins, rivets, and screw threads.

A first-rate example of GSC committee work is the development of the SAE Standard on Involute Splines, Serrations, and Inspection. As the first really complete standard of its kind, this SAE Handbook report is currently under ASA consideration. In addition, it is to be used to represent the American view point within the International Organization for Standards.

Technical Board gets 8 New Members


Burrows


Hansen


Hardig


Hemsworth

LINKED with the appointment of Dr. A. A. Kucher (see page 86) as chairman of the 1960 SAE Technical Board is the addition of eight new members. At Dr. Kucher's behest, the following have begun three-year terms. Their job: To help formulate policy on SAE standardization work.

As **WILLIAM F. BURROWS** joins the Board, he is vice president and general manager of White Diesel Engine Division. He assumed this post in 1955 after having headed the engine activity at White Motor's Cleveland engineering department. SAE-wise, he is a member of the Diesel Engine Test Code Subcommittee and Diesel Engine Activity Committee.

MERLIN HANSEN is chief engineer, new products, at John Deere's Research and Engineering Center where he supervises the design of new tractors and powerplants. The 1958 SAE Vice President for the Tractor and Farm Machinery Activity, he is currently a member of the Board's Automotive Council. From 1954 to 1957, he headed the Agricultural Tractor Test Code Subcommittee.

Studebaker-Packard's chief engineer, **E. J. HARDIG**, began his engineering career as a draughtsman for Studebaker in 1918. Prior to assuming his current post in 1955, he was chief passenger car engineer and before this, chief chassis engineer. His SAE activities include being a member of the Ball and Roller Bearing Committee and having served on the Passenger Car Activity Committee.

MARTIN HEMSWORTH manages the Component Engineering Section of General Electric's Jet Engine Department. As such he is responsible for the design and development of basic engine components for all of GE's large jet engines. Hemsworth's career at General Electric began in 1940 as a designer.

F. L. LAQUE is vice president of the International Nickel Co. and manager of its Development and Research Division. Since joining International Nickel 33 years ago, his prime concern has been with corrosion and corrosion-resisting materials. The current president of the American Society for Testing Materials, he is also vice president of the Electrochemical Society.

W. C. MENTZER, vice president of engineering for United Air Lines, has been associated with every type of plane the airline has purchased since he joined Boeing Air Transport, United's predecessor company, in 1929. He subsequently became chief engineer, director of engineering, and general manager of engineering.

W. A. PULVER, vice president and general manager of Lockheed's Georgia Division, managed the prototype development factory in Burbank when the C130 prop-jet prototypes were being built. During his 24-year Lockheed affiliation, he has worked on the P-38 fighter and Navy Constitution. Before moving to his present post last year, Pulver was chief engineer at the Georgia Division. In 1959, he served as a member of SAE's Aircraft Activity Committee.

KEITH W. TANTLINGER is vice-president, engineering and manufacturing, for Fruehauf Trailer Co., a post he assumed two years ago after serving as director of research and development *and* vice president for the Waterman and Pan-Atlantic Steamship Corps. Prior to this, he was chief engineer and vice president in charge of engineering for Brown Trailers, Inc., for nine and a half years.

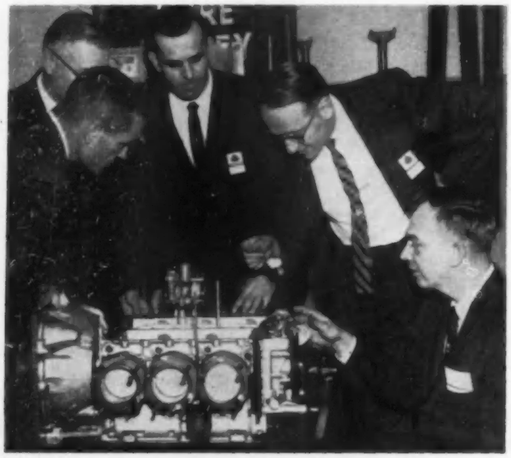

LaQue


Pulver


Mentzer

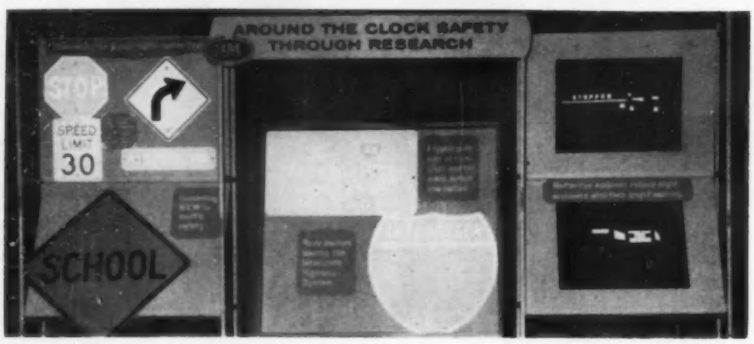

Tantlinger

Rambling Through The Sections



CORVAIR ENGINE and other major components were displayed for inspection by 200 SAE members and guests from **Twin City Section** December 9. The model above is being examined by panel members who discussed engineering areas in relation to the Corvair. They are (left to right): L. W. Foster of McCulloch Corp. who spoke about engine design problems; M. R. Koski from General Motors Training Center who discussed special maintenance problems of the Corvair; J. A. Trapp, speaker from Chevrolet Motor Division who described engineering features of the Corvair; Thomas E. Murphy of the University of Minnesota, technical chairman; and J. B. McFail from D. W. Onan & Sons, Inc., discusser of fuel and lubrication problems in air-cooled engines.

SAFETY EQUIPMENT and training aids were displayed for inspection by 180 people who attended **Northwest Section's** December meeting which was held under joint sponsorship of the SAE Section and the Washington Chapter of National Association of Fleet Supervisors. Lee Ketchum, owner of Safety & Maintenance Engineering Co. spoke on "Survival on The Highway."



X-15 HYPERSONIC AIRCRAFT, the manned missile designed and built by North American Aviation, Inc., is capable of flying at 3,600 mph and, in manned operation, attaining an altitude of 550,000 ft (in excess of 100 miles). The plane is designed to withstand temperatures of 1,200 deg F which may be reached on leading edges and other critical areas upon re-entry into the earth's atmosphere, A. L. White, engineering test pilot for North American, told **Northern California Section** at their December meeting.

White (at right) is using a model of the X-15 to explain design detail of the experimental aircraft to Meeting Chairman Roy Van Sickle, section vice-chairman, aeronautics.

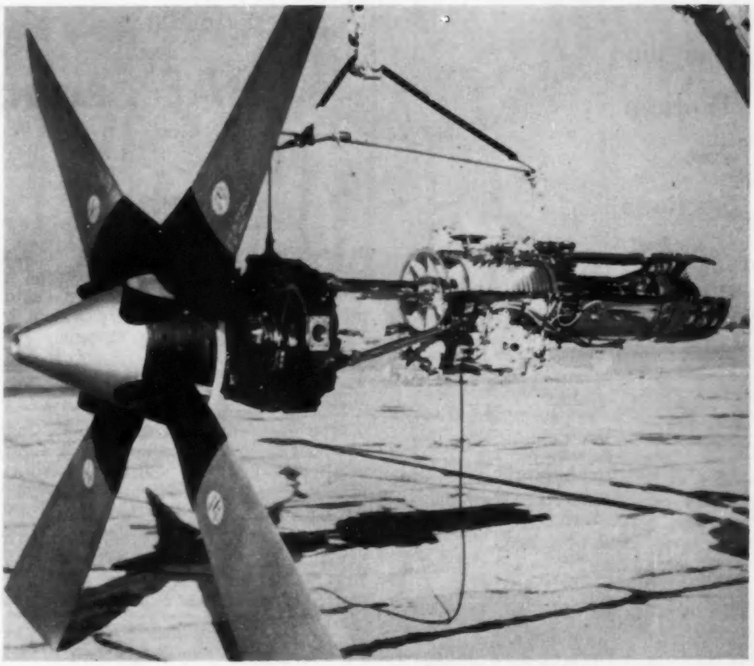
FATIGUE STRENGTH of a welded box section made of high tensile steel would probably be no greater than the fatigue strength of a similar structure made of a lower tensile steel, Thomas J. Dolan of the University of Illinois stated at **Central Illinois Section's** November meeting. Although there is an increase in the endurance limit with increasing tensile strength when the steel is in an unnotched state, the endurance limit for notched steel (representative of the welded box section) increases at a lower rate, peaks and then decreases with increasing tensile strength.

Fatigue phenomena, Dolan warned

earlier in his talk, is a statistical thing, and therefore, rigid design rules cannot be established and fatigue strengths cannot be predicted absolutely. Microscopic cracks develop at random along planes of weakness in materials. Microscopic gage lengths of the material plastically deform while the rest of the material is deforming elastically. Two specimens having the same macrostress can have vastly different microstress, and it is the latter which does the damage causing the results to be statistical.

FALCON IS THE FIRST Ford Car that was completely designed without utilizing some parts from other Ford products. The car is definitely "all new," John J. Prendergast of Ford Motor Co. told **Southern New England Section** December 3.

In order to preserve complete secrecy and to serve as an explanation of the increased activity to competitors, the Falcon was designated as the XK Thunderbird when the design was started in 1957.



THE PROP-JET gas turbine engine (shown above) converts 90% of jet engine output at the prop shaft into propeller propulsive force. The remaining propulsive force is jet thrust.

The operating noise level of this type of engine is significantly less than the jet engine and fuel economy is approximately twice that of conventional jets, E. M. Deckman told **Western Michigan Section** December 1. Another advantage of the prop-jet aircraft lies in its ability to get in and out of short airfields.

Deckman, who was senior technical man for the engine manufacturer on a recent eight week world tour of Lockheed Electra Prop-jet airplane, feels that both prop-jet and jet have their place in the future — jets for long distance operation and prop-jet for 150 mile range.

JOHN FOSTER DULLES INTERNATIONAL AIRPORT includes two sets of dual 11,500 ft runaways, oriented to accommodate current and future jet aircraft. The vast construction project, designed from its inception for jet transports, was toured by SAE members from **Washington Section.**

A wide belt of trees and shrubs will surround the airport to contain the sounds and smells characteristic of gas turbine engine powered aircraft, Arthur Geise of the Federal Aviation Agency told the section members.

Geise (above left) displays the construction plans to D. Barry Boyce, project engineer at Melpar, Inc., section vice-chairman, engineering materials; J. M. Miller of the Civil Aeronautics Administration; and Walter Flinn, staff director of defense activities at Vicker, Inc., section treasurer.

LATEST INNOVATION IN THE TRUCKING INDUSTRY is the double bottom thruway operation. A specially designed tractor for hauling the unusual double-trailer rigs of greater length and load has been developed by White Motor Co.

At their Transportation and Maintenance meeting December 7, Milton A. Hanna of White Motor Co. told **Cleveland Section** some of the conditions and requirements of double bottom operation:

On the N. Y. Thruway 127,400 lb is the gross weight limit allowable. Tractors must be equipped with tandem axles and must be able to negotiate a 3% grade (highest on turnpike) at 20 mph (speed limit is 50 mph).

In determining the engine requirements, it was decided that 290 hp was necessary for level road hauling to 50 mph on 3% grade.

The White model 5464 TDT tractor has Cummins engine, 10-speed transmission, special Timkin axle, two 100-gal fuel tanks, reinforced frame, and fiberglass tilt cab.

ALLISON MODEL 250 gas turbine engine is being discussed (above) by William Castle (right) of Allison Division GMC, speaker at **Indiana Section's** December meeting. Examining the engine are Melvin Estey (left) section chairman and Robert Guernsey, vice-chairman, aircraft.

— continued —

Rambling Through The Sections

— continued —

THE SOLUTION TO TODAY'S TRAFFIC PROBLEM may be found in the Topper Motor Scooter, William H. Harley of Harley-Davidson Motor Co. humorously suggested at **Milwaukee Section** December 14.

The Topper was designed to meet the growing demand of young people for a means of transportation. It is powered by a compact, two-cylinder engine and has only two driving controls — a hand-grip throttle to control the speed and a brake control to stop.

MORRIS MURROW (above, center) of Humble Oil & Refining Co., Research Department, spoke on "Fuels and Lubricants" at **Mid-Continent Section** December 4. Also present at the meeting were Harold Quigg (left) chairman, and Idan Flaa (right) vice-chairman, fuels and lubricants.

JIM LOOS (above left), speaker at **San Diego Section's** November meeting on ground effect vehicles discusses a model of a ground effect machine with Floyd Rechin, meetings chairman.

SAE Section Meetings

BALTIMORE

March 10 . . . Matthew L. Kalinowski, group leader, Standard Oil Company (Indiana). "Startup Wear in Automobile Engines." Engineers Club, 6 W. Fayette St., Baltimore. Dinner 7:00 p.m. Meeting 8:00 p.m.

BUFFALO

March 7 . . . C. Gordon Bennett, Jaguar Cars, Inc. "Engineering a Competition Sports Car." The Party House, 677 Beahan Rd., Rochester, N. Y. Dinner 7:00 p.m. Meeting 8:00 p.m.

March 23 . . . J. E Charipar, Plymouth Division, Chrysler Corp "The Valiant" Hotel Sheraton, Delaware Ave. near North. Dinner 7:00 p.m. Meeting 8:00 p.m.

CHICAGO

March 8 . . . Nelson R. Brownyer, vice president and director of engineering, Transmission & Axle Division, Rockwell-Standard Corp. "Automotive Differentials." Knickerbocker Hotel. Social Half-Hour 6:15 p.m. Dinner 6:45 p.m. Meeting 7:30 p.m.

INDIANA

March 17 . . . Garth Sayers, Central Engineering, Chevrolet Division. "New Chevrolet Truck Suspension." Continental Hotel, 410 N. Meridian St., Indianapolis. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Feature: Social Hour 6:00 p.m.

METROPOLITAN

March 3 . . . Air Transport Dinner Meeting. Secor Browne, Nicholas Pump Co. "Design Features and Operational Data of New Soviet Air Transports." Brass Rail Restaurant, Fifth Ave. at 43rd St., New York. Cocktails 5:30 p.m. Dinner 6:30 p.m. Meeting 7:45 p.m.

March 10 . . . Roy Hurley, chairman and president, Curtiss-Wright Corp., Wood-Ridge, N. J. "An Integrated Engineering and Development Program for Curtiss-Wright Based on the Rotary Piston Engine." Henry Hudson Hotel, 57th St. & Ninth Ave., New York. Time 7:45 p.m.

March 24 . . . George Merrick, North American Aviation. "Control System of the X-15." Garden City Hotel, Garden City, Long Island, N. Y. Time 7:45 p.m.

MID-CONTINENT

March 4 . . . Harry Hjorth, DC-8 project engineer, Douglas Aircraft Co. "DC-8 Aircraft." Douglas Aircraft Company Plant, Tulsa. Meeting 5:00 p.m. Special Feature: Movies.

NORTHWEST

March 4 . . . Bill Muncey, Public Relations & Driver of "Miss Thriftway," Thriftway Stores. "Gold Cup Report." Stewart Hotel, 2nd Ave. and Stewart, Seattle. Dinner 6:30 p.m. Meeting 8:00 p.m.

PHILADELPHIA

March 9 . . . Robert Hamilton, general manager, Guarantee Maintenance Engineering, Mack Trucks, Inc. "When Does Guarantee Maintenance Fit Into Fleet Operation." Engineers' Club Auditorium, 1317 Spruce St. Dinner 6:30 p.m. Meeting 7:45 p.m.

PITTSBURGH

March 22 . . . Student Meeting. Papers to be presented by SAE Enrolled Students from University of Pittsburgh and Carnegie Institute of Technology. 1960 SAE President Harry E. Chesebrough honored guest.

ROCKFORD-BELOIT

March 14 . . . W. R. Dalenberg, assistant manager, Form Equipment Engrg. and E. W. Tanquary, staff assistant to engineering manager, International Harvester Co. "International Harvesters' New Research Facilities." Wagon Wheel Lodge, Rockton, Ill. Dinner 6:30 p.m. Meeting 8:00 p.m.

ST. LOUIS

March 11 . . . Student Activity Meeting. Parks Air College, East St. Louis.

SOUTHERN NEW ENGLAND

March 2 . . . "Glass in 'Orbit' — Today's Engineering Properties." Corning Glass Co. Representative. Farmington Country Club, Farmington, Conn. Cocktails 6:15 p.m. Dinner 6:45 p.m. Meeting 8:00 p.m.

WASHINGTON

March 15 . . . Charles I. Fraley, The White Motor Co. "Vehicle Selection vs. Maintenance Costs."

WILLIAMSPORT

March 7 . . . Malcolm L. Land, chief engineer, Cryogenic Machinery Dept., Air Products, Inc. "Recent Advance in Cryogenic Engineering." Williamsport Moose Auditorium, East Third St. Dinner 6:45 p.m. Meeting 8:00 p.m.

SAE MEMBERS

OLIVER K. KELLEY has been named technical assistant to the general manager of the newly-created Defense Systems Division of General Motors Corp.

Kelley's General Motors career began in 1927 when he joined Cadillac Motor Car Division. Subsequently he served in engineering positions with GMC Truck & Coach Division, Detroit Transmission Division and the General Motors Engineering Staff.

His contributions to automatic transmission engineering were recognized by the National Association of Manufacturers "Modern Pioneer" award.

LOWELL A. KINTIGH, formerly assistant chief engineer at Oldsmobile Division, has been named to succeed **Oliver K. Kelley** as chief engineer at Buick Motor Division, General Motors Corp.

Kintigh joined General Motors in 1929 as a junior engineer in dynamics at GM Research Laboratories. A year later he was transferred to Oldsmobile as dynamometer operator and was made foreman in the dynamometer laboratory of the product engineering department in 1935.

During World War II he held several engineering assignments, contributing to Oldsmobile's defense program. After the war, he was made an experimental engineer. In 1949 he became assistant chief engineer.

JOHN E. HACKER has retired as manager of Crawler Tractors at Euclid Division of General Motors Corp., after serving the company 26 years.

Before joining General Motors in 1933, he was employed by The White Motor Co. in Cleveland, following service in the U.S. Army Ordnance during World War I.

While at General Motors, he was works manager at Cleveland Diesel Engine Division, works manager at Electro-Motive Division in La Grange, Ill., and plant manager at Euclid Division in Cleveland.

He is a past director of SAE and former chairman of SAE Cleveland Section.

HARRY F. DAVIS has been made general sales manager of Champion Spark Plug Co. In this position he will direct both the company's national sales program and the equipment sales division. He will be headquartered in Toledo.

Previously Davis was manager of the company's equipment sales Division in Detroit.

O. C. LEIGHTY, vice-president in charge of sales will remain with Champion Spark Plug Co. in an advisory capacity.

Leighty joined Champion in 1919 and has held executive sales positions in the field organization and in their home office. He was named vice-president and sales manager in 1954.

DEWEY E. SHERMAN, previously assistant sales manager, has been named eastern sales manager for Champion Spark Plug Co. Sherman has served the company for 34 years. Prior to being named assistant sales manager, he was district sales manager in the east.

MRS. CATHRYN WILLIAMS, engineering designer for the Department of the Navy, Naval Air Development Center, Aviation Armament at Johnsville, Pa., has been awarded a Superior Accomplishment Cash Award for sustained superior performance during the period June 1, 1958 to May 31, 1959.

JOHN L. THOUSAND has been named supervisor of systems engineering for Nortronics Division of Northrop Corp. Previously he was employed by the Allison Division of General Motors Corp. as chief, vehicle application, advanced weapon systems.

HOMI KAPADIA has been named director of overseas marketing for Mount Hope Machinery Co. In this capacity he will be in charge of coordinating and promoting the foreign sales and manufacturing activities of the company.

For the past several years Kapadia has been active in international affairs. Prior to joining Mount Hope, he was international assistant to the director of corporate planning at Reynolds Metals Co., and sales manager of Kawneer International, Ltd.

JOSEPH A. POREMBA has been appointed assistant manager of Van Dyke works, Michigan Division, Thompson - Ramo - Wooldridge, Inc. Previously he was works manager for hydraulic products. He has served the company since 1941.

— continued —

Hacker

Davis

Leighty

Sherman

Kelley

Kintigh

Williams

Kapadia

SAE Members

— continued —

GEORGE ROMNEY has been chosen winner of the ASAE Key Award for 1959 by the American Society of Association Executives. Romney is president of American Motors Corp.

DR. AUGUSTUS B. KINZEL, vice-president in charge of research at Union Carbide Corp., has been elected to a two year term as chairman of the Division of Engineering and Industrial Research at the National Academy of Sciences. Kinzel was chosen in a move to strengthen the status of engineering and increase participation by engineers at the Academy.

CHARLES R. PLUM has joined Spector Freight Systems as district manager. Formerly he served American Air Filter Co., Defense Products Division as general manager.

MILO F. McCAMMON formerly assistant general manager at Eclipse-Pioneer Division of Bendix Aviation Corp., has been named general manager of the division.

McCammon joined the Products Division of Bendix in 1941 and served as both production manager of aircraft product line and manager of manufacturing of aircraft landing gear.

In 1946 he became chief engineer and general manager of Ingersoll Steel Division of Borg-Warner Corp. In 1949 he was named general manager of Stamford Division of Yale & Towne.

He rejoined Bendix in 1951 and was appointed assistant general manager in 1955. He has served on SAE National Production Committee since 1955.

VICTOR EMERY has been made sales manager of Industrial Division of Aeroquip Corp. Formerly manager of manufacturers' sales for Industrial Division, Emery will continue to maintain headquarters at Aeroquip's Jackson Plant.

ERNEST P. LAMB, executive engineer in charge of administration for Engineering Division of Chrysler Corp., has been appointed to the Detroit Institute of Technology Board of Trustees.

Lamb has been engaged in automotive and truck design for over 35 years. In 1927, he began working as a draftsman at Dodge Truck Engineering Division. He was promoted thru the ranks to executive engineer in charge of trucks, a position he held until December 1955, when he was appointed to his present position.

Lamb is a member of Chrysler Engineering Executive Committee and Chrysler Institute Board of Administration. He is an active member of SAE National Sections Board and is chairman of its administrative committee.

Famme

J. H. FAMME, former Convair San Diego works manager at plant 2, has been named to the new post of director of Manufacturing Development for Convair. In this position he will be responsible for broadening the manufacturing development activities to include value control. He will report to **R. C. Sebold**, Convair vice-president in charge of engineering.

Famme was SAE Councelor for 1958-1959, an SAE Director in 1957, and is a member of the Aero-Space Council of SAE Technical Board.

TOM COLLINS has become assistant to president at Wells Cargo, Inc. in Las Vegas. Formerly he was vice-president of Southern Plaza Express, Inc. in Dallas, Tex.

Collins has held several offices for SAE Los Angeles and Texas Sections. He has been chairman of SAE Truck & Bus Activity and program chairman of SAE Membership Committee. In 1959 he was Texas delegate to SAE Annual Nominating Committee.

CLYDE W. LESLIE has been named vice-president in charge of research and engineering for Ryder System, Inc. Previously he was manager of Motor Truck Service for International Harvester Co.

RICHARD L. BATES has become systems development engineer for General Electric Co. Formerly he was senior development engineer at Marquardt Corp. Prior to joining Marquardt he worked for General Electric Co. as control development engineer on small aircraft gas turbines.

ROBERT N. JANEWAY, president, Janeway Engineering Co., announced completion last month of the company's expanded laboratory for dynamics research in Detroit.

Ford Division Engineering Changes

Copp

Frey

Hooven

Misch

H. A. MATTHIAS, division chief engineer at Ford Motor Co., has announced four major appointments in Ford Division's product engineering office.

H. F. COPP has been appointed assistant chief engineer — truck product engineering. Copp joined Ford as an engineer in 1946 and has served in a number of key executive engineering posts prior to his present assignment.

D. N. FREY has been named assistant chief engineer — car product engineering. Frey joined the company in 1951 as manager of metallurgical department in the scientific laboratory. Subsequently he became director of the engineering research office. Prior to his present assignment, he was executive engineer — car product engineering.

J. L. HOOVEN has become assistant chief engineer — light vehicle engineering. A Ford veteran of more than 20 years, Hooven's former position was executive engineer — light vehicle engineering, in which position he managed the Falcon engineering project.

H. L. MISCH has been appointed executive engineer — current car product engineering. A graduate of the University of Michigan, Misch joined Ford in an executive engineering position in 1957.

HENRY L. EFNER has become consulting engineer for Hercules Motor Co. Elfner retired from International Harvester Co. in September 1958. He has held various positions during the last two years and was most recently resident engineer at International Harvester's Engine Plant in Indianapolis.

Elfner has held various local SAE positions, including chairman of Indiana Section 1950–1951, and was influential in the establishment of Fort Wayne Section. He is a member of SAE Committee for Clutch, Flywheel, and Bell Housings.

E. R. STERNBERG has been appointed chief engineer of White Truck Division, White Motor Co. Sternberg joins White Truck Division after three years as chief engineer at White's Autocar Division. He came to White from Sterling Motor Co. when White purchased Sterling in 1951, and worked on special assignments until being named Autocar's chief engineer.

Sternberg

Harder

D. S. HARDER, former executive vice-president of Ford Motor Co., has been elected a director of Standard Products Co. in Cleveland.

Harder started his automotive career in 1915 and has held top positions in industry with Durant and General Motors Corp. He also served as president of E. W. Bliss Co. He joined Ford in 1957, and retired in 1959.

H. JOSEPH CHASE has been appointed vice-president and general manager of Aviation Division of Radio Corp. of America.

Until recently, Chase was vice-president of maintenance operations for Lockheed Aircraft Service, Inc. Prior to that he spent 18 months in Japan as manager of Lockheed's jet overhaul team. He has also served as vice-president and base manager of Lockheed Air Service-International at N. Y.'s Idlewild Airport.

GUY C. SHAFER has become vice-president and general manager of New England Aircraft Products Co. His previous position was general manager of Small Aircraft Engine Department, General Electric Co.

DANIEL I. McTAVISH has been appointed general manager of Auto Electric Service Co., Ltd. in Ontario. Previously he was proprietor of New Market Motors, Ontario.

WALTER F. SANDERS recently retired as president of Mountain Brake & Engineering Corp. in Tacoma, Wash.

J. C. Zeder To Retire

SAE PAST PRESIDENT JAMES C. ZEDER, who has been associated with Chrysler Corp. in executive engineering capacities since its founding in 1925, and who will retire as an officer next April, has announced his retirement as a director effective at the Board meeting held January 7, 1960. He will continue as a vice-president and special advisor to the president until he retires as an officer and then devote himself to engineering and scientific educational pursuits in which he has been engaged for many years.

He was the inspiration behind the founding and also the chairman of the SAE War Engineering Board, the agency through which the Society made major contributions to the government and the military during World War II. Later, he became chairman of the SAE Technical Board, whose organization and functioning was originally patterned along the lines of the successful War Engineering Board.

Zeder is also a past SAE Director, and has contributed a number of important papers to Society meetings.

Cited many times for his outstanding contributions to engineering, Zeder directed the pioneering of many automotive "firsts" at Crysler Corp. He has been a vice-president and director of Chrysler since 1951. He served as director of engineering and research from 1950 to 1956 and was first chairman of the Engineering Board established in 1946.

Long active in education, Zeder was one of the founders in 1931 of the Chrysler Institute of Engineering and president of the Institute from 1947. At the University of Michigan he is chairman of the Board of Governors of the Phoenix Atomic Research Project and a director of the University's Development Council. He is vice-president and trustee of Michigan State University at Oakland and a trustee of the University of Detroit.

The University of Michigan, Lawrence Institute of Technology and the University of Dayton have granted Zeder honorary Doctor Degrees in Engineering. He is an honorary member of Sigma Xi and Tau Beta Pi.

During World War II he contributed outstandingly to the achievements of Chrysler Corp. in connection with the engineering and development of military materials and weapons. He served during that entire period as chairman of the War Engineering Board for the automobile industry.

In 1950, the Secretary of Commerce appointed Zeder to the National Inventors Council and he has continued his association with this group. He is a trustee and member of Operating Committee of Automotive Safety Foundation, and trustee of Thomas Alva Edison Foundation, in addition to being active in civic affairs.

JACK WARD MYERS has become sales technical representative for Burroughs Corp., Electro Data Division. Previously he was employed by General Electric Co. as specialist for computer system programming.

WARREN E. BOUDRIE has become design engineer at General Electric Co.'s Knolls Atomic Power Laboratory in Schenectady, N. Y. Previously he was design engineer for Eaton Mfg. Co.

NORMAN SARCHIN has become owner of N. Sarchin Co. The newly formed company is a manufacturers representative organization, which will cover activities in the Pacific Northwest relative to Aircraft, Missile and Industrial lines.

Previously Sarchin was field engineer managing the Seattle Office of Telecomputing Corp.

— continued —

SAE Members

— continued —

J. DAVID MARKS has been elected vice-president in charge of production and engineering for Lehigh Valley Industries, Inc.

Prior to joining Lehigh in September 1959, Marks was employed by G-V Controls, Inc. for six years. He served them most recently as manager of engineering.

Marks was also a consulting engineer for about 12 years and has had extensive experience in ordnance and aircraft electronics.

WILLIAM MARBLE, previously assistant manager of the Engineering Activity Division of SAE, has become manager of the Division.

In this capacity he will: serve as secretary of the Engineering Activity Board, which came into formal being during the 1960 Annual Meeting; coordinate with his staff policies and plans of EAB so that they will be implemented by the Activity Committees; work closely and cooperate with other staff divisions and departments; and assume a key role in staff leadership of SAE information development function. He will be responsible to SAE management for staff operations in the information development area.

L. L. DODGE has become vice-president in charge of finance and assistant secretary for Dana Corp. Since 1958 he has been Dana vice-president in charge of administration.

Dodge joined Dana in 1948 on special assignment to the president and became executive assistant to the president in 1950. Appointed director of planning and budgets in 1953, he was the originator of a cost control and budgeting program that earned widespread recognition for its efficiency.

Prior to joining Dana, he served General Motors Corp. for 22 years in various financial posts.

WILSON A. GEBHARDT has joined the management staff at Bendix Products Division, Bendix Aviation Corp. In his new position he acts as technical assistant to D. M. Heller, assistant group executive and **George E. Stoll,** group executive and vice-president.

Previously Gebhardt was manager of aircraft engine equipment for Bendix Products Division. He has been an officer for SAE Chicago Section since 1953 and was a member of SAE Aircraft Power Plant Committee in 1955-1956, 1956–1957, and 1957–1958.

ROBERT P. ROGERS has been named manager of Experimental Manufacturing Department at Lear, Inc. In this capacity he will be primarily responsible for the Nike-Zeus build activity. He has served Lear since 1956 as a member of the engineering administration, staff assistant to the work manager, and head of Nike-Zeus Model Shop.

Ford Engine and Foundry Division Changes

Stevenson

Innes

Coleman

Horton

M. L. KATKE, division general manager at Ford Motor Co. has announced the following appointments at the Engine and Foundry Division:

ROBERT STEVENSON has been made general manufacturing manager of the division. In this capacity, he is responsible for the division's manufacturing operations, including the engine and radiator and foundry manufacturing engieering staff departments, and nine plants in Dearborn, Cleveland, Lima, Ohio, Green Island, N. Y., and Sheffield, Ala.

A Ford engineering executive for nearly 25 years, Stevenson was formerly chief engineer of the division's product engineering office.

WILLIAM D. INNES has been named to succeed Robert Stevenson as chief engineer of the division's product engineering office. In this position he is responsible for the division's 10 product engineering departments, including advanced engine engineering.

WARREN W. COLEMAN has been appointed executive engineer — advanced engine and design services. He supervises operations of the engine design and advanced engine engineering departments. A Ford engineer for 20 years, Coleman was formerly manager of advanced engine department.

EMMETT J. HORTON succeeds Warren C. Coleman as manager of advanced engine department. Horton joined Ford in 1938 as an hourly employee and was most recently assistant manager of the basic engine engineering department.

Marks

Marble

Dodge

Gebhardt

Rogers

LESLIE J. O'DONOGHUE has been named to direct the activities of the reorganized product service department, Mobile Hydraulics Division of Vickers, Inc. In this position he will be responsible for field service, publication of service literature, and product improvement, customer unit repair, customer training and services, and prototype installation assistance.

Formerly, O'Donoghue was district manager of automotive products department of Vickers. He joined the company in 1957 after 4 years service engineering experience with Ford Division of Ford Motor Co.

E. M. deWINDT has been named vice-president and director of sales of Eaton Mfg. Co. DeWindt joined Eaton in 1941 as a production clerk in the company's Valve Division.

He was named assistant director of sales early in 1959. Prior to that, he was, for five years, general manager of Eaton's Stamping Division.

He has served Eaton as assistant employment manager for Valve Division, veterans coordinator in Detroit and Cleveland, employee relations manager of Stamping Division and assistant general manager of this division prior to becoming general manager.

FRED C. RUNFOLA, formerly with Glenn L. Martin Co. as staff logistics planning supervisor and weapons systems logistics evaluation specialtist, is now senior industrial engineer, logistics in the Plans & Programs Department of Martin-Activation Division of The Martin Co. and assigned to Vandenberg Air Force Base, Calif. at the company's Titan Missile complex operations. In this capacity he is responsible for planning and programming the manpower for the Titan Missile.

ROBERT MARTIN LYNAS has become manager of Hydraulic Products Works, one of the four plants at the Michigan Division of Thompson Ramo Wooldridge, Inc. Previously he was assistant to general manager at the Michigan Division.

Lynas was chairman of the SAE Annual Meeting Session in Detroit, January 11–15; and is scheduled to be panel leader at the SAE Production Meeting in Cleveland, March 22–24; and a panel member at SAE National Aeronautic Meeting in New York April 5–8.

JONATHAN F. BUSHNELL has been made manager of Midwest Region for Fuel Injection Division of Hartford Machine Screw Co. He has been serving as sales and service engineer in the Midwest area since April 1958.

Bushnell joined Hartford Machine Screw in 1946 after service in the U. S. Navy. In 1947 he became development engineer at Fuel Injection Division for Roosa Master fuel injection pump. In 1952 he was placed in charge of assembly and testing operations, a service he performed until his appointment to the Midwest.

GERALD F. FOX, a sales engineer with Dana Corp. since 1954, has been transferred to the West Coast area, where he will serve the company in a similar capacity. Fox worked chiefly with various divisions of Ford Motor Co. while a member of Dana's home office sales staff in Toledo.

BEN F. BREGI has been made vice-president of manufacturing and research for National Broach & Machines Co. A member of the Board of Directors, Bregi was formerly vice-president of engineering.

E. B. FALK has been appointed director of advertising and public relations at Twin Disc Clutch Co. Falk joined Twin Disc in 1946 and has handled a variety of assignments in engineering, advertising and sales departments. Prior to his recent appointment he was manager of advertising and sales promotion.

R. W. KEELEY, president and general manager of Bendix-Eclipse of Canada, Ltd., a subsidiary of Bendix Aviation Corp., has received the Human Relations Award of the Canadian Council of Christians and Jews for his outstanding service to his community and his efforts to improve intergroup relations.

MANNING H. DANDRIDGE, assistant section head, Missile Power Plants, Systems Design Department at Grumman Aircraft Engineering Corp., has added responsibility as Grumman Representative at Aerojet General Corp.'s Solid Rocket Plant at Sacramento, Calif.

RALPH A. BONAFEDE has been appointed factory manager at Republic Aviation Corp. Bonafede has served the company for 19 years and was most recently assistant factory manager. Prior to that he served in various supervisory position on the production line and was appointed production manager in 1955.

RICHARD E. CLAY has been named transportation sales manager for Metals Division of Olin Mathieson Chemical Corp. He was formerly manager of automotive sales for Olin Aluminum. In his new position, in addition to automotive sales, he has been assigned marketing duties involving entire transportation market.

ROBERT W. WILSON is serving McCord Corp. as consulting engineer. Previously he was executive engineer for McCord.

GEORGE F. WEINWURM has joined System Development Corp. as weapon system engineer. Previously he was first lieutenant for the U. S. Air Force Flight Test Center at Edwards Air Force Base in Calif.

JOHN L. COURSEY has joined Associated Spring Corp. as sales representative. Previously he served Solar Aircraft Co. in a similar capacity.

O'Donoghue

deWindt

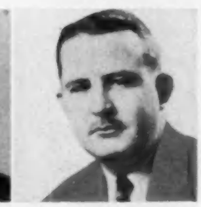
Runfola

Lynas

Bushnell

Fox

Bregi



Falk

ROBERT G. YEAMANS has become principal engineer in charge of small engines at Rocketdyne Division of North American Aviation, Inc. Previously he served them as assistant to the manager of F–108 Weapon System.

RALPH H. SHEPARD, previously hydraulics design engineer with Sikorsky Division of United Aircraft Corp., is now hydraulics design engineer at their Hamilton Standard Division.

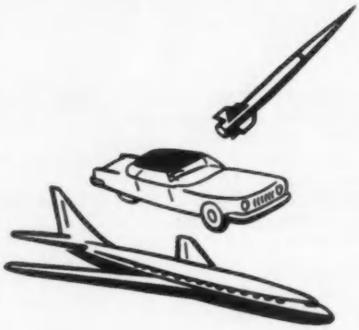
Obituaries

VERNON M. BABCOCK . . . (M'48) . . . president of Pioneer GMC Trucks, Inc. . . . died November 29 . . . born 1899.

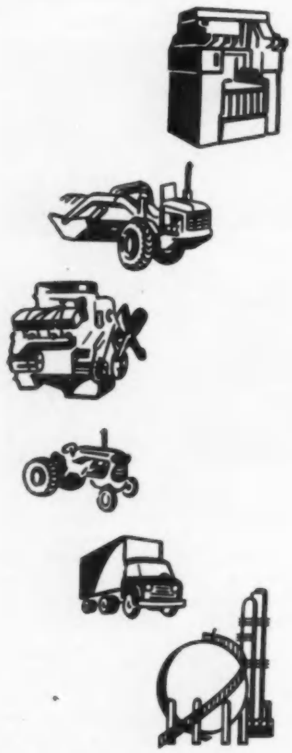
EDWARD FRANCIK . . . (M'48) . . . sales engineer at Imperail Brass Mfg. Co. . . . died December 8 . . . born 1910.

HUGH L. JACOBS . . . (M'47) . . . retired in May as manager of transportation for Magnolia Petroleum Co.'s Marketing Department (Magnolia Petroleum Co. was combined with Mobil Oil Co. in October, 1959) . . . died August 3 . . . born 1895.

J. J. POWELSON . . . (M'33) . . . chief automotive engineer for Esso-Standard Oil Co. . . . died October 11 . . . born 1896.



Wide exchange of information at SAE Annual Meeting



A BUMPER CROP of technical sessions marked the inauguration of 1960 SAE President Chesebrough and the first meeting of the new Board of Directors. When 1959 President Raymond turned over the gavel, over 6000 engineers had already had a rich technical fare at the 80-odd paper presentations and over 70 committee meetings.

The range of the information exchanged at the meeting went from production to research . . . from compact cars to exotic space-power systems . . . and from atoms to worldwide systems concepts. Capsules of the sessions start on the next column.

The new SAE Board of Directors heard of the accelerated pace of information development from its new Engineering Activity Board and reorganized Technical Board. Already 1960 looks as if it will have the biggest single pool of technical information in any year since the founding of the Society. This is one of the fruits of the recent constitution change and the implementation of the Planning for Progress program. Technical activity in the Sections is also due for a boost as a tighter bond is forged between all the information sources of SAE.

At the same time the "Project Bootstrap" started by 1959 President Raymond will push forward to insure the ever-increasing quality of the material developed for, and distributed to, the members of SAE.

At the Annual Business Meeting on Monday evening, the election of the 1960 Board of Directors was announced and the Annual Report was presented. In his presidential address, President Raymond discussed the reasons why a dues increase is necessary. (For complete story on the dues increase, see p. 81.)

Capsules of Technical Papers

DIRECT CONVERSION SYSTEMS — The direct conversion of nuclear heat to electricity is being vigorously pursued because in this way the potential of atomic energy can be realized more completely. The intrinsic temperature of the fissioning process is millions of degrees. The temperature actually obtainable is limited by the melting point, vapor pressure, and other properties of the fuel element material. The heat of the fissioning material would be converted directly to electricity in a system requiring no moving parts and able to operate at higher temperatures than those of present-day reactors.

Some of the types of converters being considered are: lithium hydride thermally regenerative fuel cell, doped lead-tellurium thermoelectric converter, closely spaced thermoionic diodes, and plasma diodes using cesium or noble gas plasma.

Present plans with the cesium conveter call for operation at 2000 C — which is roughly twice that in reactors on the drawing board. Power conversion efficiencies of up to 10–15% could probably be obtained with present versions of this type of converter. If this can be doubled, the method will become competitive with conventional machinery.

The noble gas plasma diode is being studied because it eliminates alkali metal in the diode. An experiment has been performed in the University of Michigan research reactor in which a uranium carbide cathode (which produces a plasma of relatively low fractional ionization in a noble gas) was operated at up to 2000 K.

Various nuclear electrical power systems are being considered for a manned space probe, because of strict reliability requirements. Solar direct conversion systems in the one megawatt power class are also competitive from a weight standpoint with nuclear systems.

NUCLEAR APPLICATIONS — Two important application are:

- Use of radioactivity to improve automotive safety.
- Use of the nuclear reactor to power space rockets.

The nonpower uses of radioactivity to help produce and maintain automotive transportation will increase in the future — and may even lead to devices that could greatly improve driving safety. These might include:

- Detection systems for the vehicle with respect to the roadway, which can be made simple and reliable through the use of radioactivity.
- Better methods of penetrating fog, using infrared radiation emitters.

One of the problems to be solved in the development of nuclear space rockets is the selection of the best fuel element shape. Some of the many

THE NEW SAE BOARD OF DIRECTORS held its first meeting immediately following the last meeting of the 1959 SAE Council. Head of the new Board of Directors is Harry E. Chesebrough, 1960 SAE President (left), shown here with 1959 SAE President Leonard Raymond, who led the 1959 Council.

Picture below: Raymond (right) shown presiding during 1959 Council meeting, along with, (left to right) W. Paul Eddy, William Creson, and Harry E. Chesebrough.

considerations that must be taken into account are:

- Method of retaining the fuel elements in the reactor.
- Resistance of shape to gas flow.
- Free-flow ratio (percentage of reactor frontal area that permits gas flow).
- Effectiveness with which the shape gives up its internally generated heat to the flowing gas.

New director . . .

E. N. COLE, general manager, Chevrolet Motor Division, GMC, has been selected by the 1960 SAE Board of Directors to serve for 1960 to fill the unexpired term of SAE President Harry E. Chesebrough, who had been elected to serve as a Director for 1960.

SYSTEMS ANALYSIS — It is practical to deal by logical analysis with many relatively complicated systems involving men, machines, and economic systems. On the other hand, analytical analysis become difficult when man is introduced as a part of a system and as physiology, psychology, ethics, religion, and cultural attitudes play a dominating part in the choices to be made. However, greatly improved suboptimization can be achieved if one considers, with the best approach possible, at least the next largest system above the system to be analyzed, in order to provide some guidance with respect to the "big picture."

One method of approaching a complex system engineering task is to: (1) set very high tentative goal, (2) search science and technology exhaustively for system concepts, (3) choose promptly the specific time and use for first system model, (4) initiate first magnitude research early, (5) choose first system concept and zero order design, (6) speed evaluation of model and design by use of simulation, and (7) evaluate proposed design continually using current models.

EXPERIMENTAL INVESTIGATION — At the outset of any investigation the experimenter should know whether his task in the selection of a few variables from a considerable number that could be studied or whether he is concerned with ascertaining the quantitative effects of variables already selected. There is a difference in the approach of these two tasks: The screening of the important variables from a lengthy list is usually effected by trying each variable at two or perhaps three levels. The task would be formidable if all possible combinations of these variables and their levels were investigated.

Whether an experimental investigation is very simple or quite complex, statistical methods can be used to remove ambiguities from objectives, data acquisition procedures, and data analysis procedures. The experimental uni-

verse can be represented by statistical models, then balance, randomization, and replication become the principles whose appropriate application can lead to a state of mathematical consistency between the models and the data acquisition procedures. Overall consistency is attained by requiring the objectives to ask for inference that can be reached by mathematical analysis when the data are substituted into the models.

AUTOMOTIVE COMPUTER USES — Computers are being used for a variety of automotive applications; the design of engine mounts to control shake, analysis of automotive drivetrains, and solution of complex suspension geometry problems are a few of the more important computer tasks.

The engine mounting system is more complex that it might appear because of closely grouped natural frequencies with damping. The response of such a system for a given force and frequency is the combined response of several modes. These modes cannot be separated and identified easily by experimental methods. The digital computer combined with matrix analysis forms a very powerful tool available for this task. This equipment permits rapid computation of each normal mode and corresponding frequency for an engine mounting system. This means that hundreds of different engine mounting systems can be evaluated in the time required to build only a few experimental models.

Computer analysis has increased the ability of engineers concerned with the driveline problem to deal with the increasing large number of combinations of powerplants, transmission extensions, and propshafts. In advanced design programs, the computations have been helpful in picking out the driveline lineups most likely to have vibration problems so that they might be scheduled for early test and allowed maximum lead time for development. Direct applications have been made — destructively high stresses reduced by modifications to increase the tuning ratio — but the benefits of being able to rapidly see the effect of the variation of a length, weight, or stiffness and of knowing what phenomena can and can't be explained by the given set of assumptions, are probably of the greatest value.

The application of computer facilities to the solution of a conventional front suspension geometry and related problems such as wheel rates and loads, spring-to-wheel ratio, rate of ratio change, anti-drive percentage, and steering ball joint path has opened the way to wider activity employing computer techniques.

Proposed independent rear suspension designs involving, in some cases, complex linkage systems have been programmed. These programs included means for analyzing anti-lift and anti-squat forces as well as roll versus steer characteristics. As a result of this program, the engineers had the opportunity to evaluate each design more critically than would have been possible if graphical methods had been used for the geometry solutions. For example, it was possible to make as many as forty geometry attempts for one design proposal in order to achieve every possible geometric advantage from suspension component arrangement.

As engineers and scientists encounter more sophisticated problems in applied mathematics, they are finding that computing answers using a modern, high-speed computer is just a small part of the problem solution. Other steps in the solution, such as analyzing the problem and translating it into computer language, have become much more imposing and time consuming. Unfortunately, while the computing art has made great strides with each new wondrous piece of electronic hardware, the solving art has not.

To make up this lag, people in the computer field have recently been trying to turn over to the computer more and more steps in the solving of a problem. They have, for example, greatly reduced the amount of manual programming through use of special intermediary languages like FORTRAN (formula translator) which are based on ordinary English and mathematical notation.

Going beyond these initial efforts is DYANA. For large classes of dynamic and equivalent systems, DYANA performs automatically not only the computing of a problem but also the programming and the major part of the analytical work needed in setting up the problem. Thus it eliminates the painstaking effort now involved in

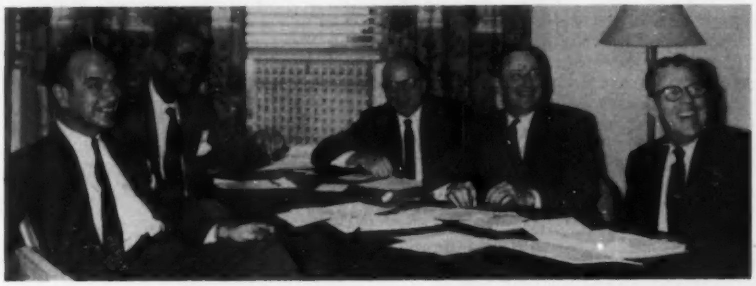
Engineering

DEVELOPMENT OF TECHNICAL INFORMATION needed by all Society members got off to a flying start at the first official meeting of the new Engineering Activity Board. Chairman Barr is shown here discussing the advances made, with various members of the Committee. Above: Chairman H. F. Barr, Karl Pfeiffer, and Harry E. Chesebrough. Right: F. W. Fink Chairman Barr, and W. Paul Eddy.

Activity Board

Complete coverage of member's national meeting needs is the objective of the new National Meetings Planning Committee of the EAB. For the first time a group specifically assigned to this problem is swinging into action. Chairman Tomkins and his committee are shown just after they had reviewed plans for the next three years. Left to right: Chairman S. J. Tompkins, E. B. Odgen, J. T. Dyment, W. L. Thompson, and R. C. Norrie.

Stimulating the flow of top technical information in optimum form to the members is the goal of new Publications Advisory Committee of the EAB. Under the leadership of Chairman Raviolo the group is also encouraging the interchange of information between the U. S. and foreign countries. Left to right: Chairman V. G. Raviolo, F. P. Steiner, T. B. Rendel, J. A. Bolt, and Robert Anderson.



Displays will provide graphic examples supplementary to the technical sessions, as often as possible, under the leadership of the new Engineering Display Committee of the EAB. Chairman Isbrandt and his members set up guideposts to implement this objective at their meeting. Left to right: Dixon Speas, E. E. Bryant, R. A. Dimberg, G. R. Fitzgerald, and Chairman R. H. Isbrandt.

For the first time the overall technical scope of the Society has been clearly defined and divided among the operating committees of the new Engineering Activity Board. Chairman Eddy and his Activities' Scope Review Committee unified the scope statements at their meeting. Left to right: Gregory Flynn, Jr., V. G. Raviolo, E. J. Manganiello, and Chairman W. Paul Eddy.

SAE Sections Board

RECOMMENDATION for an SAE Student Branch Charter for San Jose State College was proposed by Section Board member E. P. White, (center) who is also chairman of the Board's Student Activities Committee. Shown with him are Board members F. B. Esty (left) and J. H. Overwein.

FUTURE REGIONAL SECTION OFFICER CONFERENCES and stimulation of better communications between the Sections Board and the Sections through Area Coordinators were among important matters discussed by Chairman W. F. Ford and members of his Sections Board, Leonard Raymond and O. E. Kirchner.

programming, coding, and debugging a computer program. It also simplifies the analysis of a physical system to a point where a simple description and a few mathematical expressions are usually sufficient.

The measure of efficiency of any computing system is the extent to which it reduces the total elapsed time to solve a problem. This is the time from the origin of the problem to the time at which the computer produces acceptable answers. To evaluate the efficiency of DYANA with respect to this measure, a number of dynamics problems were solved using only the resources of the FORTRAN programming system. The same problems were resolved using DYANA. In each instance, DYANA reduced the elapsed time by a factor of from 4 to 8.

COMPUTERS AID GEAR DESIGN — Computers are being used to solve many problems associated with the design of gears. Typical of such problems are: external and internal gear data for spur and helical gears, including form factors for bending stress calculations, spur and helical gear meshing characteristics, tooth overlap, clearance, and backlash. Computers are frequently used for design and cutting calculations for hypoid gears. Mesh analysis of crossed axis helical gears and calculations using the balanced life concept of gear design are among other computer applications.

GROUND EFFECT MACHINES — Ford's Levacar is supported and slides along on a tissue-thin film of air. This sliding feature makes it possible to attain speeds in the 500 mph range rather than the 60 mph average estimated for other ground effect devices.

Most of the Levacar features are relatively conventional — apart from its speed — and the only significantly different items are the levapads on which these vehicles ride.

In its simplest form, a levapad is merely a flat plate with a hole in the center and an air supply forced down to create a film of air between the plate and its support. This raising of the plate, or levitation provides almost frictionless support for sliding. However, the hole-in-the-middle configuration is a very inefficient one and many other designs are possible. Among these are pool-bearing, orifice-slot bearing, porous center bearing, and modified pool bearing. Each of these is designed to extend the diameter of the high pressure center and thereby increase the load-carrying capacity of the bearing.

Current research results confirm that, in all significant performance areas, the performance of a ground effect machine (GEM) depends primarily on the ratio of its size to its height above the ground. Present indications are that large GEM's at moderate heights can provide several times better hovering performance than that of existing aircraft, together with respectable cruise performance. In the absence of extensive, flat, unobstructed land areas, operation over large bodies of water is the most attractive possibility. Some further research progress, particularly in the stability and control areas, is necessary to confirm and evaluate this possibility.

JET FUEL COMBUSTION PROPERTIES — Industry-wide standardized jet fuel seems unlikely; instead, individual airlines will probably become more and more exacting in requirements for their particular aircraft and operations. The wide-cut fuel ASTM Type B (designated JP-4 by military) has real performance possibilities for commercial aircraft, and has adequate room for combustion quality improvement. It will also remain as the single very large volume military jet fuel, with limited growth beyond 1965.

Gas turbine combustor tests have been conducted to determine the effects of fuel types. The effect of monocyclic versus polycyclic aromatic components in JP-5 fuels having the same ASTM Smoke Points on total flame radiant energy was investigated. The performance of research combustors and a J79 engine single combustor operated at low (atmospheric) pressure showed variations in aromatic type or content within the present JP-5 specification to have no significant effect on flame radiation. The performance of research combustors and a J57 engine single combustor operated at high (5–15 atmospheres) pressure showed that polycyclic aromatic fuel blends burn with higher flame emissivities than monocyclic aromatic fuel blends of comparable ASTM Smoke Point.

Fuels ranging from gasoline to No. 2 fuel oil were tested for combustor deposition and exhaust smoke at three levels of operating severity in a Boeing

502–10C gas turbine engine (220 hp). The engine didn't operate satisfactorily on any of the ASTM No. 2 fuel oils tested, on many No. 2-D diesel fuels, or even on some No. 1-D diesel fuels. The unsatisfactory operation was due to deposits breaking loose from the combustors and wedging in the turbine nozzles. The tolerance of the engine for combustor deposits decreased as operating severity increased. Fuels giving satisfactory operation at light-duty conditions also performed satisfactorily at heavy-duty conditions. Similarly, fuels giving unsatisfactory operation did so at both light and heavy-duty test conditions. Exhaust gas smoke was usually heaviest with fuels giving heaviest combustor deposits.

CONSTANT SPEED DRIVE REQUIREMENTS — USAF requirements for constant speed drives will meet future demands as follows: (1) Wider ambient temperature range capability. An aircraft electrical generating system capable of operating in a 600 F ambient temperature is being developed. Both a hydromechanical and a mechanical (friction) drive are being evaluated. (2) Dual purpose units using the CSD to start the aircraft engine. Three drive manufacturers are working on these units which will decrease aircraft weight. (3) CSD's which will be exposed to nuclear radiation environment. The biggest problem in both nuclear radiation and high-temperature environments is probably the development of a lubricating fluid which doesn't break down when exposed to heat and/or nuclear radiation.

Advances incorporated in the F-106 generating system include: electrical multiplicity — one drive, four generators, eight electrical systems — without need for inverters or transformer-rectifiers; essentially environment-free, oil-cooled, gear-driven generators; and frequency control of $\pm 0.5\%$.

Out of Boeing's experience with developing and qualifying both pneumatic and hard drive CSD's for the B-52 airplanes, have come some guide posts for design. One of these is to use a dual shut-down system where two valves are used in a series (such as an on-off valve and a governing valve). Any reason for shutdown (deliberately by operator, overspeed, loss of oil, bearing failure) should cause both valves to snap shut.

CSD DESIGNS FOR AIRCRAFT ACCESSORIES — CSD's have been designed to meet special requirements. One unit, designed by AiResearch, combines the engine starter and a low heat rejection constant speed drive. During engine operation, this CSDS utilizes the conventional air turbine starter as a speed trim to compensate for variations in engine speed and thus provides a constant generator input speed. When the engine isn't operating, this same air turbine is capable of operation as an air turbine motor to provide the required generator power at constant input speed when supplied with air from a gas turbine compressor or an operating engine. The ability to operate from dual power sources results in a multi-purpose unit which not only efficiently converts variable speed input shaft power into essentially constant frequency electrical output power during flight but also performs the following additional functions: (1) interengine bleed starts, (2) ground starting from contemporary pneumatic units, (3) ground checkout of entire electrical system, and (4) cross bleed emergency electrical power.

Sundstrand's 120 kva hydromechanical CSD is the largest aircraft device of this type to have been contracted for production aircraft. Unique and advanced design concepts include: (1) Use of fabricated housings in place of castings. (2) High speed bearings with DN values of 1.8 million. (3) Improved control system in regard to basic governor performance, limit governor performance, frequency and load

SAE Technical Board

TECHNICAL BOARD'S FIRST MEETING since its reorganization last year was held during Annual Meeting. Afterwards, 19 engineers received Certificates of Appreciation for outstanding technical committee work at a special Technical Board luncheon. (See page 84.) From left are 1959 SAE President Leonard Raymond, 1959 SAE Technical Board Chairman Ralph Isbrandt, and Incoming Technical Board Chairman A. A. Kucher. (See page 86.)

FINANCE COMMITTEE CHAIRMAN A. T. COLWELL gave a word of praise and encouragement to Cooperative Engineering Program group leaders who assist him in gaining industry support for SAE's standardization work. Other speakers at the special Annual Meeting CEP Luncheon were (at left) the Technical Board's Automotive Council Chairman George J. Huebner, Jr. and Carl Sadler (right), chairman of the Board's Aero-Space Council. Speakers not shown are 1959 Technical Board Chairman Ralph Isbrandt and Past SAE Director Cleveland Nixon. Also present was 1960 Technical Board Chairman A. A. Kucher.

Events of the Annual Business Meeting

HARRY E. CHESEBROUGH takes a bow as his election to the SAE Presidency for 1960 was officially announced.

ANNOUNCEMENT of the election of the 1960 Board of Directors was made by John A. C. Warner, SAE Secretary and General Manager.

PRESENTATION of an Honorary membership in the SAE was made by President Raymond to W. Paul Eddy (right), SAE President for 1957.

controller and frequency reference design, and current transformer accuracy. (4) Improved load division accuracy.

General Electric's 40 kva CSD for the Convair 880 and 600 jetliners was designed keeping in mind the primary requirements of airlines — reliability, safety, long life, and low operational cost. Low cost operation and reliability are probably the most important — and equipment life is the key to both. Since internal (or working) pressure is the most important factor in determining drive life, one way to achieve the 2000 hour design life objective was to select a very conservative rated load working pressure of 1200 psi. Oil temperature is also important. So the normal maximum continuous oil temperature is 275 F, with a maximum temperature of 315 F. This selected range allows good lubrication and optimized drive performance.

UTILITY AIRCRAFT — As travel requirements for the future increase, a greater and greater segment will be taken by the airplanes of general aviation. Such a means of travel enables a businessman to go when he wants, stop where and when he desires, eliminating the rush and wait frequently experienced with other forms of transportation. Also, it enables him to cover more miles and obtain more customers than would be possible otherwise.

One company says, "It is impossible to say with any certainty to what extent the intangibles of prestige, customer good will, and the minimizing of travel fatigue on the part of our executives and engineers can be said to compensate for the operating costs of the aircraft."

The expanding use of aircraft by business has produced many new problems including: acquisition, operation, maintenance, scheduling, and efficient utilization of the aircraft. Meeting these problems brings the additional headaches of hiring, training, proficiency checking, upgrading, and proper placement of highly specialized manpower assigned to fleet duties. To make effective use of its aircraft, a company must solve these problems.

INTEGRATING MISSILE GSE — To obtain the goal of operational suitabilty in a system sense, the following must be considered in the design of ground support equipment — weapon design, and operational, maintenance, logistics, and personnel concepts. The problems associated with integration of GSE are essentially reduced to that of utilizing existing experience data and the evolutionary improvements of proven equipment and techniques.

For example, successive designs of launcher shelters for the BOMARC defense missile have maintained reliability by stopping and reversing successive increases in mechanical complexity. . . . At the same time, construction costs were lowered by reducing quantity of construction materials. A prototype designed for the latest version of the BOMARC was subjected to extensive roof operating tests under simulated combined snow loads (30 psf) and wind loads for specified operation during 60 mph gusts. Throughout, the roof opening was fast (4 sec), dependable and automatic. And reductions in cost were very pronounced over earlier models. Shelter designs may be further changed due to Air Force interest in increased invulnerability to direct attack.

SOLVING JET TRANSPORT SYSTEM PROBLEMS — Experience and testing are pointing up the problems associated with jet transport pressure fueling and landing gear and tire systems. These problems are being corrected by cooperation between manufacturers and airlines. Tests were

made to determine conditions causing surge in the DC-8 fuel system. Before testing was concluded, Douglas Aircraft was able to release to the airlines parameters covering fueling equipment to prevent damage to the DC-8 during fueling. These include: (1) Fueler valve initial opening time to eliminate start-up surge. (2) Fueler valve sensing time to eliminate rapid surge during aircraft fill-valve shut-down conditions. (3) Fueler valve pressure control tolerances to insure stable pressure delivery to the aircraft during single or dual point fueling. (4) Fueler maintenance and inspection procedures to insure unit is functioning as designed.

Experience with the Boeing 707 landing gear, made primarily of high-strength steels, showed that such steels are susceptible to rapid fatigue cracking at stress riser or high stress areas. Service failures indicate the need for improved fatigue testing, including use of photoelastic plastic techniques and full-scale wood models. Another problem brought to light was galling of the truck beam and its pivot bolt — caused by very small angular movement between the bolt surface and the beam. Other areas were also found where pinjoints have worn quite rapidly due to surface roughness. The corrective action being taken is to provide replaceable bushings and chrome-plated pins with much smoother surfaces.

RELIABILITY PROGRAM — Achievement of product reliability is dependent upon the ability of each individual worker to perform his reliability task in an informed, intelligent, and diligent manner. Reliability control techniques should be designed to provide the individual with clear direction, definition, and tools essential to the understanding and accomplishment of his assignment. The techniques should also provide the ability to budget and control the reliability characteristics and to make prompt, sound decisions based on factual evidence.

AUTOMOBILE CRASH SURVIVAL — What happens to a motorist as he is tossed around inside his car during an intersection-type collision? Certain interior design features, more than any other single cause, are responsible for the variations in degree of injuries sustained by motorists within the same car. They frequently give mute testimony as to why, for example, one motorist sustains only minor to moderate injuries, while another riding in the same car becomes a fatality. From the standpoint of machine efficiency and dependability, the modern automobile creditably reflects the continuing product research and development activities of the industry. Although the industry has in recent years conducted some collision research, interior design for passenger safety during collision has not kept pace with other improvements. The crashworthiness of the automobile is clearly the responsibility of the industry and it is critically essential.

AUTO AIR POLLUTION IS 40% CRANKCASE GAS — Tests show that hydrocarbon emission from the crankcase is of the same order of magnitude as that due to exhaust. Blowby gases are predominately carbureted mixture. So specific hydrocarbons in the fuel determine the specific hydrocarbons in the crankcase gases. Feeding engine crankcase gases back to the intake system eliminates crankcase hydrocarbon emissions without appreciably affecting exhaust emissions. An internal crankcase ventilating system can thus eliminate about 40% of the engine hydrocarbon emissions (considering crankcase plus exhaust, under all operating conditions) exclusive of carburetor vent losses.

COMPACT CARS, U. S. STYLE — The Big Three of the American automobile industry this year joined the trend toward smaller cars with the introduction of the Corvair, Falcon, and Valiant. Basic features of the cars are as follows:

Corvair — Unitized body. Opposed 6-cyl aircooled rear engine, with a 40% front, 60% rear weight distribution. Compression ratio 8/1. Curb weight 2382 lb. Engine displacement of 140-cu-in. Bore 3⅜ in., 2.6 in. stroke. Transaxle assembly.

Falcon — Unitized body. In-line 6-cyl front engine. Compression ratio of 8.7/1. Weight 2350 lb. Engine displacement of 144.3-cu-in. Bore 3.5 in., 2.5 in. stroke.

Valiant — Unitized body. In-line, 6-cyl front engine. Compression ratio of 8.6/1. Bore and stroke of 3.4 × 3.12 in.

MILITARY UTILITY TACTICAL TRUCK — The M151 ¼-ton military utility tactical truck will carry a driver and three passengers, or may be used to carry 800 lb of cargo cross-country or 1200 lb on the highway. When fully loaded it will also tow 1500 lb cross-country or 2000 lb on the highway.

It is designed to operate under all weather conditions, will start without aids at −25 F ambient temperature and, when equipped with a gasoline heater for engine preheat, will start and perform in −65 F ambient temperature. By direct contrast, it also will perform at 115 F ambient temperature without auxiliary cooling aids. It will ford hard-bottom water crossings at a depth of 20 in. and, with the addition of snorkels for air intake and exhaust, can be operated completely submerged in 5 ft of water. It has the capability of climbing a hard surface grade of 60% when fully loaded, and it has a

1959 BUCKENDALE LECTURE was given by George J. Huebner, Jr., whose topic was the Computer-Based Selection of Balanced-Life Automotive Gears. Following the lecture which was given during Annual Meeting, Huebner (left) received a certificate and cash award from E. P. Lamb, chairman of the L. Ray Buckendale Lecture Board.

2500 NEW SAE MEMBERS is the goal of the Membership Committee in 1960 . . . bringing Society membership up to 26,000. From left are R. E. Johansson, J. H. Dunn, Membership Committee Chairman W. J. Lux, M. J. Durella, W. E. Thill, N. P. Mollinger, and R. W. Rand.

Among the honored guests at the reception held before the dinner were (left to right): 1960 SAE President Harry E. Chesebrough, Dinner Speaker Dr. Marcus Long, professor of philosophy at the University of Toronto, and 1959 SAE President Leonard Raymond.

Engineers' Responsibility to Society

"ENGINEERS have done great and wonderful things for man, but they have also provided him with the means for destroying the entire human race, both body and soul." Thus, warned Dinner Speaker Dr. Long, every engineer, as an individual, must remember that he, too, is a member of society, and must bear his share of responsibility for the machines engineers have devised.

He pointed to two of the engineer's accomplishments — the now operational ICBM Atlas and the hydrogen bomb — as proof of the arrival of pushbutton warfare . . . and man's ability to destroy the human race.

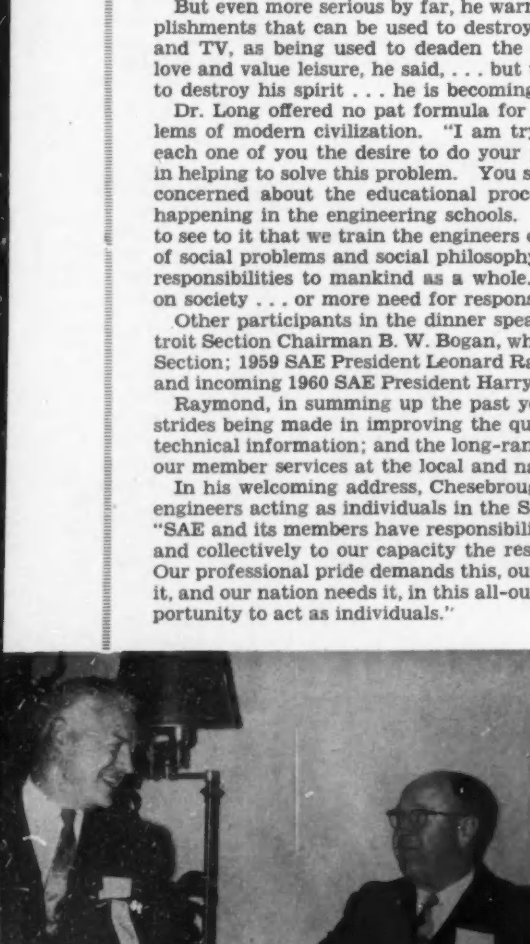
But even more serious by far, he warned, are the engineer's accomplishments that can be used to destroy men's souls. He cited radio and TV, as being used to deaden the spirit of man. Man used to love and value leisure, he said, . . . but today man is using his leisure to destroy his spirit . . . he is becoming a mere vegetable.

Dr. Long offered no pat formula for solving these profound problems of modern civilization. "I am trying," he said, "to awaken in each one of you the desire to do your part, as a member of society, in helping to solve this problem. You should, for example, be greatly concerned about the educational process . . . particularly what is happening in the engineering schools. You should do what you can to see to it that we train the engineers of tomorrow to be more aware of social problems and social philosophy . . . and to understand their responsibilities to mankind as a whole. Nobody has more influence on society . . . or more need for responsibility than the engineer."

Other participants in the dinner speaking program were: SAE Detroit Section Chairman B. W. Bogan, who extended greetings from the Section; 1959 SAE President Leonard Raymond, who was toastmaster; and incoming 1960 SAE President Harry E. Chesebrough.

Raymond, in summing up the past year's activities, pointed to the strides being made in improving the quality of our meetings and our technical information; and the long-range plans being laid to enhance our member services at the local and national levels.

In his welcoming address, Chesebrough stressed the importance of engineers acting as individuals in the Sixties. In conclusion, he said, "SAE and its members have responsibilities to contribute individually and collectively to our capacity the results of which we are capable. Our professional pride demands this, our Society membership requires it, and our nation needs it, in this all-out battle for the continuing opportunity to act as individuals."



C. C. Dybvig (left), chairman of the Dinner Program Committee, is shown here conversing with B. W. Bogan, SAE Detroit Section chairman.

maximum drawbar pull of 2100 lb when carrying 1200-lb payload.

RATING BRAKE CAPACITY — The need for a reliable and convenient way to rate brake capacity has long been evident. Stopping ability as an index to brake performance is well established, but a good braking system also has other characteristics which must be evaluated. This evaluation rests largely upon subjective considerations, because standards suitable for gaging performance other than stopping ability are lacking.

Some interesting relations can be developed by considering energy relations involved in the stopping of a vehicle as compared to holding a steady speed down a given grade. Two important input conditions can be recognized: (1) the transient phase of stopping or bringing about a decrease in speed; and (2) the steady or sustained state where the vehicle speed remains substantially unchanged, but a more or less constant input into the retarding mechanism is necessary to balance the effect of gravity. The transient condition is characterized by very high input rates involving comparatively small amounts of energy. On a downgrade contrary conditions prevail, input rate being quite nominal and the total energy transferred large.

POWER TRANSISTOR IGNITIONS — Higher efficiency automobile engines have placed heavy demands on the voltage available from ignition systems. Greater spark gap lengths and higher compression ratios have raised voltage requirements throughout the speed range. Higher speed engines and the wider use of 8-cyl engines emphasize the need for adequate high-speed performance from the ignition system. This need for either ultra-high voltage or ultra-high energies at the spark plug dictated the exploitation of the solid electronic switch — the transistor.

A power transistor system would: (1) be rugged, (2) eliminate warmup time (no filaments), (3) operate directly at 6, 12, or 24 volts, (4) operate over a wide range of battery voltages from cold starting to normal operating, and (5) permit miniaturized circuitry.

NEW LOOK AT STIRLING ENGINE — A maximum theoretical performance per unit weight of working fluid in a Stirling cycle has been derived. This optimized output applies universally to all Stirling engines, irrespective of whether it is in the form of mechanical work for prime movers, heat elevated to a higher temperature level for heat pumps, or a cooling effect in refrigerators, as long as the main basic assumption of isothermal operation applies.

It has been shown that for given operating temperatures and clearance ratios an optimized geometrical layout applies, which fixes the phase angle

setting and the volume ratio of the two main working spaces. For rationally designed machines with optimized portions and phasing, the output is in all cases considerably more than that of corresponding symmetrical machines. This increase is particularly pronounced in refrigerators and heat pumps and may amount to several hundred percent.

RATING DIESELS FOR HP, WEAR — A subcommittee of the SAE Engine Committee has proposed corrections to the SAE Diesel Engine Test Code in an effort to provide a more realistic method of correcting horsepower output of diesel engines.

The basic correction method proposed is the constant air/fuel ratio method. This method is intended to determine the output under standard conditions when the fuel rate is adjusted to maintain equivalent combustion conditions or exhaust smoke density. The method is based on the assumptions that the following exist at test and standard conditions: volumetric efficiency is constant; combustion efficiency at a given air/fuel ratio is constant; friction horsepower is the same at test and standard conditions.

The new CRC Diesel Engine Rating Manual is intended to furnish a universal language for identification of diesel engine deposits and wear. Diesel engine pistons are evaluated for lacquer deposits by utilizing an area demerit basis and color gradations of brown and gray from clean to black. In studying various means for evaluating thickness and texture of deposit in oil systems, it was decided that the scratch gage developed by the CRC Engine Deposit Rating Panel of the CRC — Motor Engine Varnish and Sludge Group was suitable for diesel engines. A procedure for establishing a volume factor which furnishes a weighted interpretation of the deposit was created.

BATTELLE RESEARCH — A few years ago Battelle initiated a research program aimed at devising a new and superior gas air-conditioning unit for residential use. The new unit was to be competitive in first cost with an electric air conditioner and have a significantly lower operating cost. Battelle concluded that an internal combustion engine combined with a vapor-compression-refrigeration system would provide the solution if an effective means of combining these two elements could be obtained. With an engine and compressor to combine, the logical choice was the free-piston engine. In keeping with the objectives of low cost, simplicity was stressed by the use of a single piston having a combustion chamber at one end and a compressor on the other end. The single-piston free-piston configuration shows promise of providing low noise level and long life — key factors in the acceptability of residential air conditioning systems.

Battelle, in conjunction with Fairbanks, Morse and Co., have found that radioactive cylinders provide a valuable tool for wear research. The effect on cylinder wear that is experienced with variables such as starting, idle or cold temperature operation, sudden load changes, speed, torque, and such, can be determined easily and relatively inexpensively. Simultaneous data can be obtained on rings and cylinders, or other wearing parts of an engine through the use of different isotopes and pulse height analysis. Local areas may be monitored through selective irradiation of the cylinder in conjunction with pulse height analysis.

FLUIDS — PUMPS AND SEALS — Hartford Machine Screw's new Roosa Master fuel injection pump, Model DB, meets its objective of standardization. The pump is available with a single housing configuration that can be mounted either horizontally or vertically as demanded by economies and by installation provisions on various engines. The pump drive is arranged so that the driveshaft stays with the engine upon removal. This results in only one coupling being used between the engine and the pump.

Development and research work in lip seals during the past two years has shown that production variables in seal manufacture and the lack of adequate inspection equipment for control of these variables is a primary cause for "leakers" which occur immediately or shortly after a product is put into service. In most instances an adequate design can be made and satisfactory operation can be attained for a majority of seals in the same application. Those that do leak are perhaps less than 1% of the total, which in most cases can be directly attributed to physical characteristics resulting from

... guests at pre-dinner get together..

Here are some of the displays seen at the technical sessions . . .

MODELS OF VARIOUS TYPES OF POLYMER MOLECULES. Dr. H. F. Mark, who presented a paper on basic polymer concepts as applied to automotive engineering, is shown here displaying one of these models, which represents a long-chain molecule.

A WORKING MODEL OF THE STIRLING ENGINE. This model stirred up much interest when it was displayed in connection with a series of papers describing new developments and studies being made of this very old concept for a type of external-combustion engine.

SCALE MODEL OF THE MODEL IV SHELTER designed for the BOMARC missile was shown at the session at which a paper on launcher shelters for BOMARC was presented by R. V. Ostling and P. M. Kelly of Boeing.

EXAMPLES OF DIFFERENT TYPES OF TECHNICAL REPORTS and reference works. This display was part of a session sponsored by the SAE Publication Committee, to show how to use the ideas and words that spark engineering action; and to get the data on which it is based.

production variables such as lip diameter, lip pressure, and eccentricity.

NUMERICAL CONTROL — Numerical control is essentially a communication system which allows flexibility in design engineering. Under such a system, dimensional data in the form of numbers is transferred from the original source to a media such as tape or cards, and used as instructions to a logic unit that operates a machine tool. Data processing is required for translation of data when continuous data of the machine tool is necessary to produce the defined shape, and is best performed by high-speed digital computers. Cutter center path, speeds, tolerances, and sequence are converted by the computer to the number or code used to actuate the machine.

The computer makes many decisions which might otherwise be made by an operator, and thus reduces the likelihood of error. For example, it compensates for cutter geometry, generates detailed points on the cutter path, resolves feed velocity in components, programs slowdowns, generates parity check digits, and arranges information in control tape form.

BODY CORROSION — Body corrosion of passenger cars is an ever-increasing problem, especially because of the use of anti-icing materials on streets.

American Motors has found use of a deep primer dip coating of their unitized bodies effective protection for inside surfaces. Critical areas are further reinforced with an application of inhibited wax. The deep primer dip coating under the fender-wheelhouse areas is reinforced with another spray-applied coat of the same material, which is then baked. The underfender are heavily sprayed with a layer of asphaltic sealer. The whole wheelhouse-fender area is then sprayed with a heavy layer of asphaltic sound deadener.

General Motors has run laboratory tests of steel panels, studying corrosion resistance. Their results indicate that lead contamination is consistently present in higher amounts on the surface of steel found to be most susceptible to corrosion when phosphated and painted. Further tests are necessary to determine whether this is the only factor.

SOUND REDUCTION IN UNIT BODY — Noise transmission is more critical in unitized cars than in conventional body construction. Chrysler met the problem in their "Unibody" as follows:

Engine noise and some drive line disturbances were controlled through improved isolation of the powerplant. The front engine mounts were changed to a vertical shear type employing large amounts of rubber. The rear engine mount was conceived as a coil spring in series with a rubber compression

THE PAST-PRESIDENTS ADVISORY COMMITTEE heard with interest 1959 President Raymond's story of his recent European trip. He was welcomed by and talked before nine technical societies; visited six countries. A March SAE Journal article will report the highlights of his visits and observations.

mount. Increased isolation was also provided in linkages and cables. Axle noise was brought under control after the development of improved suspension isolation, resulting from increased use of rubber and a new technique in specifying the compounds of rubber parts. Body panels resonant in the road noise frequency range were treated to change the natural frequency with reinforcing bead or strainers, or to reduce the amplitude with deadeners.

NEW POLYMER APPLICATIONS — Engines, transmissions, and fuel systems offer many interesting and intriguing problems for the application of polymers. Here the main requirements are reversible and supple deformability over a wide temperature range, resistance against plastic flow, heat distortion, chemical degradation and solvent swelling. Phenolics, polyamides and fluoropolymers are now in use, in such capacities as fuel line tubings, gears, membranes, and gaskets. Better and less expensive materials will become available and the prospect is that there will be an increased use of polymers in the domain of the powerplant of a car in the near future.

FUTURE ANTIFRICTION MATERIALS — Cermets and ceramics are being considered for anti-friction bearings exposed to temperatures above 1500 F. The cermets are cemented carbides. Titanium carbide appears to be the most successful. Tungsten carbide is entirely unsuitable, because it oxidizes and flakes badly when exposed to air at high temperatures. Chromium carbide is sensitive to both thermal and physical shocks. Control of the size and shape during sintering is difficult, and diamond grinding is slow and expensive.

Ceramics for bearings are in the experimental stage and likewise present problems in production and because of brittleness. The great differences in thermal coefficients between the cermets and ceramics as compared to shaft and housing materials present problems in design because of the possibility of races cracking on shafts or becoming loose in housings.

It is inferred that the approach to the greaseless car lies in plastics. The most stable of all plastics is the fluorinated version of polyethylene, polytetrafluoroethylene, more commonly known as Teflon TFE fluorocarbon resin. Teflon, combining high temperature resistance and low coefficient of friction, is the outstanding candidate among the plastics when properly reinforced or treated, to be designed into greaseless automotive bearing applications. Also considered as bearing-type plastics are nylon, FEP fluorocarbon, and acetal resins which are tough and wear-resistant plastics. The latter two classes are in the development production stage at this time. All of these plastics have one property in common. They are all difficult to adhere to other substrata when adhesion is desirable. The importance of anti-stick is of prime importance in a bearing for dry or unlubricated applications because this results in little or none of the slip stick phenomenon.

ONE FLUID FOR TRANSAXLES — Transaxles fluid development has passed the 75% point of engineering development to meet Corvair automatic transaxle requirements. Several specifications have been fully met — including antifoaming, wear resistance, lubricity, and volatility. When a final fluid is produced, it will no longer be necessary to seal off the axle and automatic transmission sections of a transaxle. Transaxles for manual shift cars can now use one fluid because of less severe requirements. Currently, an SAE 80 multipurpose axle oil is used in conjunction with a phosphated ring gear on the manual shift transaxle.

(As a result of tests conducted at the GM Research Laboratories, three mineral-oil-base fluids and one synthetic-base fluid obtained from suppliers, and one additive-base stock combination blended at the Research Labs merited further investigation.)

The major problem proved to be selecting e-p additives that provide adequate gear scoring protection without chemical attack on clutch plate facings. The testing direction taken was to come as close as possible to the actual operating condition that would be encountered in yet-to-be produced Corvair Powerglide transmission. Fluid development is also being measured by static friction tests to determine the effect of temperature on coefficient and the relation between static and sliding coefficient.

EVALUATING DIESEL LUBRICANTS — Diesel lubrication evaluation problems are being solved by a variety of testing techniques. The Navy has two types of unsolved problems in the exploitation of new high-output engines — piston pin lubrication and exhaust port plugging. A Kinetic Oiliness Test Machine and other bench test equipment is being used to determine the effects of specific zinc and phosphorus compounds on piston pin and bushing lubrication. And a study is also planned to determine whether a better solution can be found to the problem of reducing port deposits. (Navy has been using Series 3 oil in 5 submarines for this purpose.)

Laboratory bench test methods have been used by the California Research Corp. to evaluate the silver lubrication characteristics of crankcase oils. Correlation has been obtained between a silver strip corrosion test and silver connecting rod bearing weight loss in standard diesel engine tests. (Silver rod journal bearings operate principally in the hydrodynamic lubrication region.) And, using the KOTM, a silver friction test technique was developed that correlates well with silver-plated wrist pin bearing performance in one make of railroad locomotive engine. (Wrist pin bearings in 2-cycle engines usually operate under boundary lubrication conditions.)

Thermal-oxidation stability test apparatus has been developed at the Southwest Research Institute to provide industry with a reliable method of qualifying military gear lubricants. The apparatus predicted thermal-oxidation stability with good repeatability and field correlation. It was used, also, to isolate the effects of oxygen and temperature on the thermal-oxidation degradation phenomena. The apparatus, which simulates field conditions, has a wide operating range with respect to temperature, gas metering and gear loading.

SPACE-AGE FARM EQUIPMENT — The space age presents some interesting possibilities for improvement in farm machinery. Indications of evolutionary advances in farm machinery are apparent today; for instance, there is a newly announced tractor of high horsepower that is suited particularly to large acreage farms. This tractor permits the use of 8 to 10 bottom plows and 31-ft disc harrows. Such a machine could be equipped with an elementary automatic guidance system with relatively little effort. An additional step in automatic guidance

Well attended, as shown above, was the 1960 SAE ENGINEERING DISPLAY, which was the largest in SAE Annual Meeting display history. Although several companies wishing to display had to be turned away for lack of space, the move to Detroit's new convention center for the 1961 display is expected to ease this situation. Present plans call for over 550 booths in 1961 at the World's Fair of Automotive Engineering!

might represent a somewhat larger step into the future, and involve buried cables, radioactive pills, or slugs of inert metal laid out in specific patterns.

As agriculture moves toward complete mechanization the role of the worker will change to that of system supervisor. This change from manual labor to judgment and supervisory control may not permit a reduction in mobility and the necessity of working in unfavorable environments, but will place a greatly increased emphasis on personal efficiency. Heat and dust are two major factors in reducing efficiency, and respirators and grin-and-bear-it do not provide an acceptable answer. The space-helmet type of personal environment control consists of a light plastic cap with a transparent plastic face-shield. Attached to these is a light elastic fabric skirt which may be tucked under the wearer's clothing. A knapsack-type pack contains a filter, cooling unit, battery pack, and two-way communicator. Earphones and microphone attached to the cap, and a flexible hose from pack to cap complete the assembly.

In use, buttons on the pack can select a few communicator frequencies and a simple on-off thermostat controls the cooling unit. Spent air from the helmet is discharged from under the neck-flaps about the wearer's torso. The unit will, as far as possible, be designed to permit normal freedom of motion. The battery pack may be recharged at any outlet or a retractable cord will permit operation of the unit from any farm equipment the wearer is running.

JET GROUND PROBLEMS — The introduction of jet-type aircraft into the military supply system has further complicated airport snow and ice removal operations because of the high speeds at which planes land and because of the jet engines' performance characteristics. A jet pilot must rely on the plane's brakes and wing flaps to bring it to a halt although some military jet aircraft use retarding chutes. Since jets are unable to provide a reverse thrust similar to that of propeller-type aircraft, the runway surfaces must be dry and skid-proof. It isn't permissible to utilize sand, salt, or chlorides to provide a non-skid surface and to melt the ice because of the corrosive and abrasive effect these materials have on the planes and their jet engines. Not only must the runway be ice-free for landings but also for take-offs. The runway surface must provide resistance to prevent wheel slippage during engine warmup.

Towing tractors for airplanes of the Boeing 707, Douglas DC-8, and Convair 880 weight class are required to operate under the reduced coefficients of traction common with snow and ice. They also must be a compromise "least objectionable" to the airlines in the interests of economy. After study of specifications prepared by various airlines and discussion with airlines' engineering and operations people, it was decided that the compromise tractor for these jets should have: gasoline power; 4-wheel drive (2-wheel drive option); 4-wheel steer (2-wheel and crab steer option); 30,000 lb static drawbar pull on a concrete surface; torque converter and power shift transmission; road speeds to 18 mph; 10,500 lb drawbar pull at 5 mph and 5500 lb drawbar pull at 10 mph; 37.5 kva power unit compartment; maximum height of 60 in. without cab; maximum height of 88 in. with cab; maximum width of 96 in.; and a maximum length of 220 in.

MAINTENANCE MANAGEMENT — A tool of strong management is "organization." The better this tool is, the easier it is to do the job. Strong management or organization — for a maintenance man — begins by tying responsibility and authority together throughout the department, from the truck on up. Until the fleet superintendent can assume more responsibility in the overall transportation picture, fleet costs can hardly be trimmed as effectively as future business conditions will surely demand.

One way of doing this is to set up an Operations and Maintenance Department, with the responsibility of rearranging the procedure of maintenance, retooling the shops as needed, building new shops in some cases, and remodeling shops in others. Such a department would permit standardization of procedures and put maintenance on a production line basis. This department can suggest design changes for new vehicles, avoiding recurrence of problems found in old vehicles.

Manpower remains the key, however. The rapid development of the trucking industry has brought new specifications, new products, intricate components, and the need for more accurate fits and adjustments. The tools and shop equipment have become more complex. Today a good mechanic must have a high degree of know-how. In a modern shop highly skilled men are needed as diagnosticians, engine rebuilding machinists, electrical specialists. The days of the grease monkey are over and management must realize it.

AIDS TO PRODUCT QUALITY — The quality of products produced by a manufacturing concern depends to a large extent upon the quality attitude of all employees and their desire to do the job right the first time. Thus it is in the best interest of any concern to develop to the fullest a proper quality attitude on the part of all its employees.

Harrison Radiator Division of GMC strives for better quality through improved communications with employees and recognition of accomplishments made. Displays are set up throughout the plants which give examples of good and poor quality. Progress curves are prominently exhibited to show quality improvement. Employee incentives include merchandise and monetary awards, quality plaques and banners, and quality award luncheons.

Research tools, too, can go a long way toward providing better products at lower cost. Michigan Tool Co., a medium-size company, uses such tools as: an angular interferometer to check indexing tables and indexing plates; a high-speed camera which permits slow-motion observation of machining operations; vibration checking equipment for checking motors, spindles, and the like; metallurgical control equipment for quality control of tool steels; and strain gages to assist in designing machines and perishable tools.

ENGINEERING LITERATURE — The selection of outstanding literature in the field of automotive engineering is complicated by the very nature of that subject. A personal library for the automotive engineer would have to cover the fields of mechanical engineering, electrical engineering, physics, chemistry, mathematics, and metallurgy, as well as his own specialized areas.

The company or public library must, therefore, be a constant source of information for the engineer. The library is a place where he can obtain answers to specific questions, study and examine current literature in both his own and allied fields so as to orient his own activities with those of his fellow engineers, and review the works of the ancients.

Library research is but one part of the preparation of a good technical report. To get results from every report he writes, an engineer must: (1) choose the action he wants the reader to take, (2) select an approval-getting summary, (3) write the report in terms that will get fast approval, (4) arrange the report for easy reading and use, (5) verify facts, English, and presentation, and (6) deliver the report to his superiors in such a way that it gets full attention.

SAE Engineering Students . . . seeking summer employment in 1960

For complete address, write:

SAE Placement Service
485 Lexington Avenue
New York 17, N. Y.

Telephone:
OXford 7-3340

Location desired in bold face type.

* available April '60.
** available May '60.
others available in June '60.

Assumption University of Windsor

Ontario — R. M. EAGEN,** ME '63 — Desire work in automotive or allied field with opportunity of gaining practical engrg. experience.

Bradley University

St. Louis — CRAIG POLLARD, BS '62 — Seek summer employment with a company doing research & testing of automotive components.

Open — D. B. ROSINE, BS '61 — 3 yrs experience as truck & bus mechanic. Very interested in construction, operation & maintenance of these vehicles. Would like especially to get into Diesel engine construction & maintenance.

California Institute of Technology

Boston — J. D. CROSSMAN, '62 — Desire practical work in mech. engrg. field to supplement my education.

Open — H. G. HARTUNG, BS '60 — Seek summer job to gain experience in engine (any kind) design; major subjects design & thermodynamics; will get Master's Degree in '61.

California State Poly. College

Denver, Calif. — J. F. NIELSEN, BS '61 — Experience in automotive field. Desire placement in research along these lines.

L. A. or San Fernando Valley — J. D. SEWELL, BSME '61 — Seek summer job as mech. engrg. draftsman. Have had experience.

West Coast — F. W. MAYHEW, BSME '61 — Would like experience in product sales dept. of engrg. firm. Have some sales & public relations experience.

Calif., Nev., Ariz. — J. S. ARNOLD, BSME '61 — Desire summer job that could lead to permanent position as design engr.

Los Angeles — HENRY HANSER, '61 — Desire connection leading to career in heavy construction. Have some engrg. experience.

So. Calif. — R. E. NELSON, ME '61 — Have had some experience in rocket motor testing & would like employment that would lead to a permanent position as a rocket engine test engr. upon graduation.

L. A., Pasadena — JOHN HAYASHI, BS '61 — Would like job which will give me experience in my field of mech. engrg. Would also like to know of opportunities for a graduate M.E.

Calif. — R. L. WOODS, BSME '61 — Desire summer job in the oil industry. Previous summers include field work in production, drilling & exploration depts.

Pasadena, L. A. — J. H. ALLISON, BS '62 — Have no previous experience but would like to break into any mechanical engrg. field.

Carnegie Institute of Technology

Cleveland or Pittsburgh — PETER NOBLE, BSME '61 — Desire summer job with firm doing aviation devel. work especially in the field of commercial aircraft.

City College of New York

West Coast — STEVE SHEPARD, BME '61 — Most interested in eventually doing engrg. writing in field of thermodynamics as applied to missiles & rockets. Currently coeditor of VECTOR, CCNY engrg. magazine.

Open — MICHAEL KESTENBAUM, BME '61 — Prefer summer job in some phase of metallurgy. 1 summer's experience in metallurgy working for USA Ordnance Corps in Indus. Processes Unit, Watervliet Arsenal.

Detroit Institute of Technology

Detroit — R. V. SCHNEIDER, BSME '61 — Desire summer job with mfg. co. Am interested in position that will give me experience which can be applied toward work as Mfg. Supervisor.

Ecole Polytechnique

Montreal — PAUL COBETTO,** P. Eng./BASc '62 — Would like to gain experience in metallurgical field. Am in 3rd yr. engrg. (metallurgy). Will consider relocation.

Montreal — CORBEIL GILLES,** '63 — Seek summer job in aircraft industry with view toward acquainting myself with various design & special ballistics problems.

Hamilton — HUBERT D'AMOURS,** Met. E. '62 — Seek experience in summer job. 2 summer jobs in Mines Mills indicated I like to be with workers. Interested in working with metallurgists. Speak English/French.

Montreal — F. E. MORISSETTE,** BScA '61 — Interested in Admin. Engrg., Sales Engrg. Worked during summers as estimator & asst. to sales district engr.

Open — J. G. LORRAIN,** '62 — Want a job which might give me practical experience in automotive engrg. Some experience in steel work last summer.

Open — CLAUDE BORDELEAU,** '62 — Seek job which would give me a chance to learn well, work hard, & make my employer interested in hiring me again next summer. Most interested in eventual work in Admin. Engrg.

Fresno State

Western U.S. — R. M. SHAWL, BS '61 — Interested in any type automotive work. Hope to become automobile dealer.

Georgia Tech

Macon/Atlanta, Ga. — D. C. PROCHAZKA, BSME '62 — Desire summer job in some phase of mech. engrg. preferably automotive but also interested in other aspects.

University of Illinois

Detroit — ROBERT WILK, BS '61 — Prefer position which necessitates ingenuity & resourcefulness with the possibility of travel.

Chicago or so. suburbs — DENNIS DELAURA, '62 — Desire connection leading to position in automotive or diesel engrg.

Lawrence Institute of Technology

Detroit — W. E. McHALE, BSEE '61 — Interested in gaining experience as an Admin. Engr.

Detroit — D. R. KRAUSE, BS '61 — Desire summer job which might be first step in

Listing continued on following page

SAE Engineering Students . . . seeking summer employment in 1960

* available April '60 | ** available May '60 | others available in June '60

equipping me for responsible work as electrical engr.

Royal Oak, Detroit — D. I. VAN BLOIS, EE '61 — Am interested in summer job dealing with electronics. Prefer research work. Have 4 summers of work in radio & television repair business.

Los Angeles — JON ABBEY, ME '61 — Desire work dealing in suspension systems of automobiles, or styling of body parts.

Loyola University

Los Angeles area — C. R. BEYERLE, BS '61 — Very interested in aero. research & design. Have completed 4 yrs of college leading to BS in Mech. Engrg.

Manhattan College

No. N. J./N. Y. C. — J. J. BLASS, BS '62 — Seek summer job with machinery mfg. co. 1 summer job has provided some practical experience.

N. Y. area — ANTHONY CAVALLI, BSME '62 — Seeking job which would lead to position as an automotive engr. after graduation.

New York — W. G. BURGER, BME '61 — Interested in gaining experience in engrg. field especially in the automotive industry or aeronautics.

University of Maryland

Baltimore — M. D. STREAKER, BSCE '61 — Interested in public relations & desire individual responsibility. Experienced in the field of mech. engrg. Details of previous experience available.

McGill University

Montreal — R. G. KALAU,** BME '61 — Seek summer employment in diesel or gasoline engine design. Some practical experience provided by previous summer work.

Michigan College of Mining & Technology

Michigan — REINER DENISON, BS '62 — Seek summer employment that will correspond with Automotive & Machine Design options in Mech. Engrg.

Missouri School of Mines

St. Louis area — D. F. MARKEL, BS '62 — Seek job which will use my math. & drawing education & give practical experience for a Mech. Engr.

St. Louis area — N. R. HOPKINS, BSME '61 — Prefer work to prepare for future in Industrial or Admin. Engrg.

Open — ROGER ECHELMEIER, BS '61 — Seek opportunity in sales & management with plans of eventual work in Admin. Engrg.

New York University

New York — MICHAEL OSTRELICH, ME '61 — Desire position in field of electromechanics specifically in computer research & devel. or servomechanisms. Have arranged curriculum to complete courses of major interest by June. Employed part time for Mech. Engrg. Research Dept. of NYU.

Northrop Institute of Technology

Los Angeles area — MANUEL ESCALANTE, JR., BS Aero. Elec. Major, Dec. '60 — Desire part-time job with co. mfg. electronic components. Most interested in semiconductors. Seek job which might be helpful as a future Electronic Engr.

Los Angeles — J. A. GARCIA,* EE '60 — Seek part-time job with co. in electronic field which may equip me for responsible work as an Electronic Design Engr.

Northwestern University

Chicago — W. H. SHINEFLUG, BSME & MBA '60 — Plan to complete my work in graduate school of business admin. & desire a summer job with mfr. of diesel engines. Have 4 yrs experience in fuel injection.

Ohio State University

Columbus, Dayton, Springfield, Ohio area — J. W. PAUL, BME '61 — Seek summer work with automotive or aircraft co. Interested in high speed internal combustion engines & prefer job which may lead to a supervisory or managerial position as opposed to isolated design.

N. East Central States — T. T. CODDINGTON, BSME '61 — Seeking a summer job in mech. engrg. field. Have previously worked as a student asst. in the engrg. drawing dept.

Oklahoma State University

Open — RICHARD KRIVY, '61 — Seek job which might be first step in equipping me for responsible work as Design Engr. Interested in safety aspects. Auto. Mechanic. Wrote 12 page research paper on "Automotive Design for Safety." Have experimented with some of my own ideas.

Midwest — J. D. CRIBBS, BS '61 — Seeking summer employment in stress analysis or design.

Penn State University

Open — D. J. HESTON, BSME '61 — Desire work leading to a position as a design engr.

Los Angeles — D. R. WEISEL, BSEE '62 — Desire summer job in an electronics lab.

Harrisburg & York, Pa. — J. H. HARLOW, JR., BSME '62 — Desire summer job with co. dealing with some type of automotive engrg. Have had some practical experience.

University of Pittsburgh

Pittsburgh area — J. P. HESS,* '62 — Most interested in being a lab. asst. or technician in order to gain experience. Also interested in draftsman work & have 1½ yrs experience.

Near Pittsburgh — J. R. ECKELS,** '61 — Have had light experience in various steel making processes, garage work, & other fields having little to do with auto. engrg. Desire a summer position which would offer the most practical experience in basic engrg.

Pittsburgh — J. R. DOUGHERTY,* BSME '61 — Desire summer job which will lead to future position in automotive field. Have had 4 summers' experience with an auto. parts co.

West or Midwest — S. A. BECKER,** BSME '61 — Seek summer job in either automotive or aero. field. Most interested in work on prime movers or propulsion equipment. Previous summer experience with gas turbines.

Pittsburgh district — R. S. ZIELES,* '61 — Seek a job which might be the first step in equipping me for a position in power production engrg. & in diesel engrg. design.

Pittsburgh — J. A. OTT,* BS '61 — Desire summer work in any type Mech. or Indus. Engrg. that could lead to a permanent connection. Prefer work which could lead to management position later in life.

Pittsburgh — JERRY GORDON,* BSME '61 Seek summer job to gain experience in research or design work.

Pittsburgh — L. L. SCHNEIDER,* BS '61 — Desire a summer job which would equip me with a basic understanding of design engrg.

Pittsburgh — H. L. KANESS, JR.,* BS '61— Most interested in Admin. Engrg.

Polytechnic Institute of Brooklyn

New York State — L. J. SPADACCINI, ME '62 — Seek summer position which might be first step to eventual work in Admin. Engrg.

Purdue University

Indianapolis, Chicago area — J. A. CIESAR, BS '62 — Seek experience in original research. This will supplement my background in preparation for graduate study.

Ohio — M. F. MILLER, '62 — Interested in job which will further my experience in field of design.

Chicago or Detroit — H. C. HASSEL, '62 — Seek job which would be first step in preparing me for future work as an automobile designer (stylist).

Central U.S. or Calif. — L. W. McGLADE, BSME '60 — Entering U. of Iowa next yr for Masters degree in Bus. Ad. Seek summer job in automotive or earthmoving field in automotive engrg., purchasing or personnel management. Top 35% of class. Have taken ICE & Diesel engine courses as tech. electives. 2 summers' experience Asst. Shipping Mgr. for paint co.

San Jose State College

San Francisco Bay area — ALEX DANKS, BS (Aero.) '61 — Seek summer job with aircraft mfr., airlines or aircraft repair service which will lead to permanent position.

University of Saskatchewan

No. Canadian Prairies or B. C. — A. G. A. PEARSON,* '61 — Would like employment in smelter or design of smelting operations. Interested in metallurgy & metallic alloys.

Stevens Institute of Technology

N. Y. Met. area — HARVEY FRIEDMAN, ME '62 — Seek summer job which would give me experience in mfg. or indus. research or in indus. engrg.

Continental U.S., preferably N. Y. C. — M. A. JACKSON, ME or BE '62 — Desire position in which I may gain experience in Tech. Illustration (private co. or publisher) &/or

. . . continued

packaging design & if possible, near automobiles.

N. Y.-N.J. Met. area—ALFRED KUEHN, '61 — Am interested now in sales & eventually in Admin. Engrg. Very interested in working with people (public-human relations).

Texas A. & M.

Dallas, Tex. — R. W. BURTON, BSME '61 — Interested in admin. or sales engrg. & enjoy working with other people.

Houston area — F. B. HUDSPETH, ME '61 — Seek summer job with firm concerned with lab. engine testing.

University of Washington

Northwest — P. G. CLARK, BSME '60 — Seek summer job with design or testing section. Going to graduate school in Fall of 1960.

Wayne State University

Detroit area — K. H. TOKEN, BSME .61 — Desire connection leading to position in automotive industry, preferably in design or development.

Detroit — PAUL COLANDREA, EE '61 — Seek summer job connected with use of electronics in automotive research, testing or production. 3 yrs experience in military service as electronic technician.

Detroit area — J. F. HILL, BSME '61 — Desire position which will provide background in mfg. equipment & processes. Would like a position which will be helpful in selling metal processing equipment. 15 mos. experience detailing, illustrating & minor layout of truck special order equipment & accessories.

Detroit — DAVID ROBINSON, ME '63 — Interested in product layout drafting or heavy detailing job. 3 yrs experience.

Detroit area — P. G. HENDRICKSON, BSME '61 — Desire job leading to position in internal combustion engine *design* or design of its component parts. Have worked for Vickers doing layout & detailing of hydraulic power units.

Detroit — NICK PAMPHILIS, BA '61 — Prefer to work with power plant factories in diesel engrg. design or in any place dealing with heat & power. Of course, any engrg. job will be acceptable.

Detroit — EUGENE SCHAFRANEK, '61 — Am a senior in college of engrg. (mechanical), graduating in Feb. '61.

Open — R. J. BARFKNECHT, '61 — Desire summer employment in research or dev. Mech. Engrg. Senior with eye towards MS in Engrg. Mechanics. 3 summers engrg. experience.

University of Wisconsin

Open — J. A. UDKLER, BSME '61 — Prefer summer job in aircraft field. Particularly interested in helicopter work. 3½ yrs helicopter maintenance experience in USAF & 1 yr of general aircraft work as civilian.

Open — C. M. TORAASON, BSME '61 — Desire summer job that will give me experience in field of design & development of I.C. engines. Will be second semester senior in spring of '60.

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1959-1960

continued

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ft and structural changes were made to make the fence more frangible.

A louvered type of fence is now required for terminal aprons to:

- Divert the blast upward.
- Avoid turbulence at adjacent gates.
- Preclude chances of objects or equipment being blown over the fence.
- Provide partial vision through the fence.

Jets are now permitted to taxi in under power, but must be towed from the ramp to a remote point before starting engines. This was necessitated by two events. On one occasion the starting blast picked up a 530-lb baggage cart and blew it over the fence for 75 ft. In another instance, full power applied to free tires frozen to the pavement damaged one passenger loading stand, two panel trucks, one air conditioner, one tug, and several glass panels in the terminal building.

Additional shoulder paving has been provided on all taxiways to prevent erosion of unpaved shoulders and minimize ingestion of foreign objects. But it is not a cure-all. Recently, a jet making a stationary full-power runup, blasted out a 30 × 50-ft area of asphalt pavement.

To Order Paper No. 109T . . .
on which this article is based, see p. 6.

New Factor of Safety Concepts

Based on paper by

CHARLES LIPSON
University of Michigan

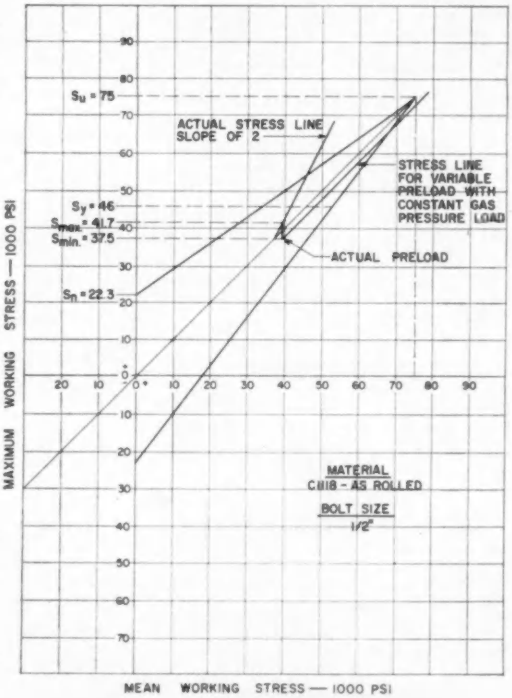

Fig. 1 — Goodman diagram for determining factors of safety for compressor head bolts.

Are Applicable to Engine Design

A SAFETY factor is determined from stress and strength analyses, but the manner of comparing the two analyses depends upon the pattern of loading and resultant stresses. Four patterns of stress are considered here. They are where:

1. Preload stress is constant, and the fluctuating stress varies, being additive to the preload.
2. Preload stress is constant, and fluctuating stress varies, being completely reversed about the preload axis.
3. Preload stress is constant, and fluctuating stress varies, being subtractive from the preload.
4. Preload stress varies, and the fluctuating stress is constant.

Application to Compressor Bolt Design

To illustrate how these concepts can be applied, let us assume the problem of designing bolts to seal the head of a reciprocating compressor having a 10.5-in. bore and a cylinder pressure varying from zero to 200 psi.

After initial analysis indicates that six bolts, made of SAE 1118 material, will be used, the problem becomes one of determining bolt size.

Table 1 — Factors of Safety for Compressor Head Bolts

Bolt Size, in.	A_s, in.^{2}	σ_{min}, psi	σ_{mean}, psi	σ_{max}, psi	σ_{var}, psi	S_y, psi	Factory of Safety: Based on Excessive Tightening Torque	Factory of Safety: Based on Excessive Gas Pressure
½	0.1374	37,500	39,600	41,700	4,200	46,000	1.22	3.83
9/16	0.1816	27,800	29,650	31,510	3,710	46,000	1.65	5.90
⅝	0.2256	22,100	23,680	25,260	3,160	46,000	2.08	7.70

The stresses are determined from the conventional relationships:

$$F_i = CF_e \frac{K_c}{K_b + K_c}$$

$$F_t = F_i + \frac{K_b}{K_b + K_c} \times F_e$$

$$\sigma = \frac{F}{A_s}$$

where:

F_i = Tightening load
F_e = External load due to gas pressure
F_t = Total load acting on the bolt
σ = Stresses resulting from the above loads
A_s = Stress area of the bolt
K_b = Elastic constant of the bolt
K_c = Elastic constant of the mated members
$C = 2$

Table 1 gives the stresses for three bolt sizes. The stresses for the ½-in. bolt are plotted on the Goodman diagram (Fig. 1) from which factors of safety can be determined. In this determination, two cases must be considered:

1. Where the tightening load can be taken as constant and the only consideration is that the design must be guarded against increases in gas pres-

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sure, with a resultant failure of the bolt.

2. Where the gas pressure can be accepted as reasonably constant and the design must be guarded against overtorquing the bolt, with the resultant bolt failure.

Obviously, the design must be strong enough to avoid both eventualities. The first belongs to the category of pattern 1, since the preload (tightening torque) is constant, and the fluctuating stress (gas pressure) varies, being additive to the preload. The second is illustrated by pattern 4, since the preload (tightening torque) varies and the fluctuating stress (gas pressure) is constant. Accordingly, two factors of safety are determined as shown in Fig. 1 and Table 1. For the case where the gas pressure is constant and tightening torque varies, the limiting stress in Fig. 1 was taken as the yield point of the material (S_y in Table 1) to conform to general engineering practice.

The factor of safety governed by possible excessive tightening is smaller (see Table 1) than the one from possible excessive gas pressure. Therefore, the design is governed by avoidance of overtorquing.

This factor of safety for the $\frac{1}{2}$-in. bolt, as determined from Fig. 1, is 1.22 and therefore not sufficient for a failure-free operation. The 9/16-in. bolt gives a factor of safety of 1.65, which appears adequate. For critical applications it might be necessary to go to $\frac{5}{8}$-in. (factor of safety of 2.08), although this may lead to possible overdesign if the requirements are less stringent.

To Order Paper No. 120T . . .
on which this article is based, see p. 6.

New Brake-Retarder For Heavy-Duty Trucks

Based on paper by

D. A. Gotsch
Auto Specialities Mfg. Co.

AN OIL-COOLED, multiple-disc brake for service braking and retarding has been developed and tested by Auto Specialities. Fig. 1 shows the construction of the unit.

Cooling oil is sealed in the brake structure with two dynamic seals, one located between the outer housing and driver, and the other in the wheel hub, replacing the standard wheel bearing grease seal.

Twelve discs make up the brake stack. There are six rotors driven by the brake driver through six machined lugs on the inside diameter, and six stators located and held in position on anchor pins between the inner and outer housings on the outside diameter. Metallic lining is sintered on both sides of the rotors. A lining size of $14\frac{3}{4}$-in. OD by $11\frac{3}{4}$-in. ID is used because tests indicate the most desirable ID/OD ratio to be 0.80. The lining area per rotor is 75 sq in. to give a total of 450 sq in. per brake.

The brake is hydraulically actuated with a conventional 15/1 ratio air over hydraulic power cluster. The hydraulic fluid is introduced into the annular cylinder machined in the inner housing. The cylinder is sealed with a silicone rubber quad ring followed by a backup washer of Teflon, which bears on the aluminum annular piston.

Automatic adjustment is provided by three adjusters per brake, located 120 deg apart on the primary disc.

Service brake testing was done on a 2-axle vehicle loaded to 25,000-lb gvw, with 18,000 lb on the rear axle and 7000 lb on the front. Ausco brakes were installed on the rear axle while the front axle had conventional $16 \times 2\frac{1}{2}$-in. air brakes. Maximum decelerations were attained at a 1400-psi line pressure, adequate to skid the rear tires. These decelerations amounted to 22 ft/sec/sec at 20 mph, 20 ft/sec/sec at 40 mph, and 18 ft/sec/sec at 50 mph.

An accelerated durability test which scheduled 4050 stops from 45 mph at a deceleration rate of 15 ft/sec/sec at 1.2-mile intervals, with a stop made in reverse after every tenth stop, showed

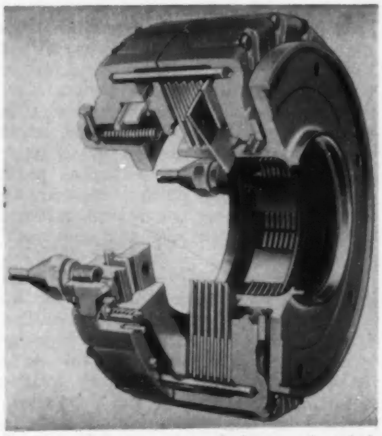

Fig. 1 — Cutaway view of Ausco oil-cooled, multiple-disc brake-retarder for heavy-duty trucks. Tests indicate a lining service life of 300,000 miles.

a stack wear of 0.086 in., or 30% of the available stack wear of 0.280 in. Based on lining wear obtained with conventional brakes tested on the same schedule, the projected service life of the linings is 300,000 miles.

Retarder tests were run on several tortuous grades in Arizona, using a 2-axle tractor and tandem axle semi-trailer combination having a gvw of 57,300 lb distributed as follows: front axle 6240 lb, tractor rear axle 18,570 lb, and trailer bogie 32,490 lb. The two Ausco brakes alone were used for retarding. The ambient temperature was 93 F.

On Superior Mountain, the retarder was used to limit road speed to the posted 25 mph. The hydraulic line pressure required varied from 200 to 300 psi. The maximum brake oil temperature was 245 F, which stabilized and remained constant after 4 min of application time. Total time required to descend the 4-mile, 6–7% grade was 9.6 min and the maximum radiator water temperature recorded was 160 F.

To Order Paper No. S207 . . .
on which this article is based, see p. 6.

Past Developments Key to New Turbojet

Based on paper by

DAVIS G. PHINNEY

Pratt & Whitney Aircraft

WHEN development of the 3000-lb thrust, JT12 turbojet was undertaken — a strictly company project without government assistance — the decision was made to take full advantage of known technology and to avoid major incursions into wholly new areas. This "playing safe" policy was adopted to assure that the product would be up to reliability standards while cutting development time to meet delivery requirements.

The general design appearance of the JT12 is similar to that of the JT3. The JT12 has several stages of aluminum stator vanes. The stators are assembled by dip brazing and so are the inlet guide vanes, whose case extends back to the midpoint of the compressor. The stators continue the JT3 and JT4 strengthening feature of an integral inner shroud. The highly successful brazed internal fuel manifold of the JT3 is continued, but a single fuel nozzle is used in each of the eight cans. The louvered cooling arrangement also is repeated.

There is also close resemblance to the JT4 in design approach. This is noticeable in compressor rotors and turbine rotor construction. The JT12 employs JT4-type pin-jointed-root titanium blades in early compressor stages, dovetail-root steel blades in later stages, minimum compressor blade length greater than that of the J52, and fir-tree-rooted shrouded forged turbine blades in both stages as in all stages of JT3 and JT4.

Many thousands of hours of rig testing of main shaft bearings and seals were conducted in developing the JT3 with the result that very little develop-

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ment was required for the JT12 other than oil scavenging corrections. The fuel system components are conventional lightweight design, a modification of the J52 engine control.

The JT12 is not a copy or a scaled-down job. It took a great deal of ingenuity to design an engine with a thrust specific weight of 0.146 lb per lb of thrust and to avoid destructive resonances in thin sheet metal parts and in the rotating system.

To Order Paper No. 103U . . . on which this article is based, see p. 6.

Two Techniques Hot-Form Titanium

Based on report by secretary

C. O. COFFER
Ryan Aeronautical Co.

TWO METHODS used for hot-forming titanium sheet are: heating the blank and forming on unheated dies, or heat-both the blank and the dies.

The least costly and more expedient method is the use of furnace heated blanks and an unheated Kirksite die — lead punch drop hammer combination. The lead punch may be covered with a mild steel sheath to prevent lead pickup and deterioration of the punch. Acceptable parts of many types can be formed with this method. Part tolerances are fairly good when proper techniques are used. Closed-angle parts cannot be formed by this method, although subsequent bench work is sometimes used to overcome this shortcoming.

A refinement of the heated blank-unheated die method of forming involves the use of resistance heating. The advantage of resistance heating over furnace heating is that the blank is pre-positioned and may be formed immediately after heating, thus eliminating the transfer problem. For a given heating temperature, the forming temperature is higher than when furnace heating is used, and the forming temperature can be more closely controlled. One disadvantage of resistance heating is that extra material must be allowed for electrode contact. A second disadvantage is that the blank temperature will vary with varying blank dimensions. If the blank is of non-uniform width, the wider portions will be colder. If the blank is curved, the outer section of the curve will be colder. This effect can be satisfactorily overcome by cooling the hotter areas with air jets.

The heated blank — heated die method of forming offers several advantages over the methods based on the use of unheated dies. In some instances, it is the only practical way of forming close tolerance parts.

With heated dies, the material may be heated very closely to the desired forming temperature. The parts may be allowed to dwell on the die after forming so that most of the forming stresses are dissipated. This results in parts that closely match the die configuration. If a stress-relief is required, this can be accomplished during the forming operation and part distortion or relaxation which might occur during a furnace heating cycle is avoided.

The maximum permissible temperature used for forming depends on the total time at temperature and on the particular alloy being heated. The maximum temperature may be dictated by embrittlement characteristics, heat treatment response, or scale removal problems. The minimum temperature usually depends on formability requirements or, possibly, by stress relief requirements. Generally, the lowest temperature which will result in the required formability is the most desirable.

Lubricants are generally necessary to prevent scoring of titanium during forming. Heavy oils, dry film lubricants, or molten salts may be used. The descaling problems are usually more difficult when lubricants are used. In using molten salt or a dry film lubricant, care must be taken to prevent a buildup in the radii or other areas of

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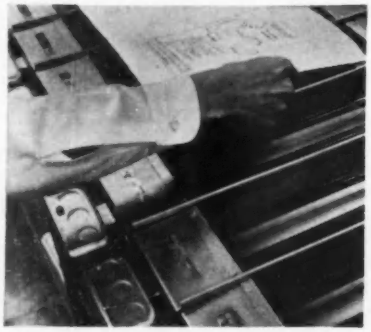
HOW TO GET MORE USEFUL HEAT PER KW



It's not much to look at, but our new VYCOR Brand Radiant Heater is loaded with advantages for those involved with drying, baking, curing or pre-heating.

The basic appeal of this unit is the kind of heat it gives you—*long wave;* efficient because it's readily absorbed.

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Long wave output is just one reason why your kilowatts will yield more useful heat. This heater also has a reflector *system* that includes a platinum strip bonded to one side of the tubing, and two layers of aluminized steel with Fiberglas insulation in the housing.

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Heating tubes come in 14″, 26″, 38″ and 54″ lengths, mounted in twos or fours. You get each unit complete with frame, reflector sheet, junction box, mounting hangers and leads.

More facts? Use the coupon.

NEW MATERIAL FOR MISSILE MAKERS AND OTHERS WITH HIGH-TEMPERATURE PROBLEMS

The biggest drawback to fused silica, despite its many desirable thermal and electrical properties, has been the limitation on sizes and shapes available.

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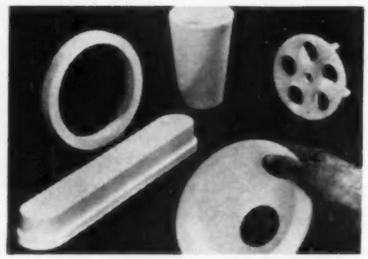
With Multiform Fused Silica you can put the useful properties of fused silica to work in shapes and sizes that previously were unattainable.

For example, you can now have cylinders, domes, crucibles, rods and slabs—in sizes equal to any achieved by conventional ceramic forming processes.



Corning's new Multiform Fused Silica offers the unique thermal and electrical properties of fused silica in shapes and sizes that up to now were considered impractical.

Softening point for this new material is 2880°F; you can design for *long-term* use at temperatures over 1770°F, intermittent up to 2250°F.

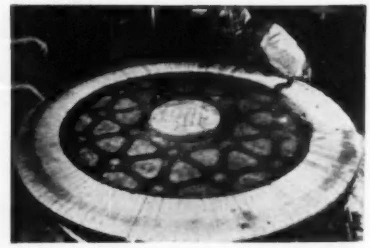
Resistance to thermal shock is high, since coefficient of expansion is 3×10^{-7} per degree F.

This new material also displays an extremely stable dielectric constant and a low loss tangent over a broad temperature range. Example: At a frequency of 8.6×10^9 cps, the dielectric constant is 3.58 at 77°F and 3.57 at 750°F.

Through either slip-casting or dry pressing you end up with an object (a radome, perhaps?) that has an opaque, fine-grained structure machinable to tolerances of plus or minus .001 inch.

For samples of and/or detailed specs on new Multiform Fused Silica, mark the coupon and send it to our New Products Division.

A MIRROR FOR THE STARS



This is a glass telescope mirror blank that measures 84 inches across and weighs 4,000 lbs.

We made it. And we did it with a new process in which solid chunks of glass were placed in a mold and *sagged into a single piece* under intense heat.

Back in the thirties we also made some big mirrors. But then we ladled molten glass into molds and came up with a 200-inch disk for the Hale Observatory on Mt. Palomar and a 120-incher for the Lick Observatory.

Our new sagging approach improves quality. It also costs less and is less complicated.

Seven months the disk was annealed. Now at the Kitt Peak Observatory in Arizona, grinding and polishing will go on for an estimated 24 months. Final polishing will be done after the telescope is fixed on a star. Time for that? Another year.

Leading us to these facts: Patience is part of the art of the astronomer. And Corning can do almost anything with glass—be it a "one-shot," hand-tailored piece or *mass production of small items at a very rapid pace.*

Find out for yourself. The basic references are "This is Glass" and Bulletin IZ-1, "Designing with Glass for Industrial, Commercial and Consumer Applications."

Or outline your need in whatever detail seems feasible. Could be your star is just around the corner, with glass by Corning.

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the die as an excessive buildup will result in marking of the part. Graphite films have proved satisfactory for heated die applications. Molybdenum disulfide does not serve quite as well, but has the advantage of decomposing at forming temperatures, so that die buildup is not a problem.

SERVING on the panel which developed the information in this article, in addition to the panel secretary, were: chairman **A. L. Smith**, Ryan Aeronautical Co.; **F. J. Peterson**, North American Aviation, Inc.; **J. W. Chambers**, Marquardt Corp.; and **L. J. Hull**, Ryan Aeronautical Co.

This article is based on a report of one of production panels on aircraft production subjects. All 16 are available as a package as SP-329. See order blank on p. 6.

How to Save Money On Fleet Paint Upkeep

Based on paper by

RUSSELL L. SEARS
Acme Quality Paints, Inc.
Affiliate of Sherwin-Williams Co.

SEE that trucks are well painted to start with, practice good housekeeping, choose the proper time to repaint, and use best quality paints. These are the maxims for fleet upkeep.

Original paint jobs on trucks range from good to fair. The average new truck is primed with a 0.5 to 0.7-mil coating of a medium grade primer and has a finishing enamel film thickness of 1.5–1.7 mils, which is baked (several use air dry enamels). This is below the quality used for passenger cars. In many cases, interior cab finishes are applied directly to steel without prime coating. Some bus and trailer manufacturers are doing a better initial job of corrosion proofing.

Frequent washing and adequate inspection are essential to insure early repair of minor damage to the paint film. Costs will be repaid in the long run and appearance will be maintained in the meantime.

The cost of paint is only about one-tenth the cost of application, so it is a waste of money to use inferior material. Beware of miracle paints containing magic ingredients, paints that do any and all jobs equally well, or are claimed to permit shortcuts in surface preparation prior to painting, and paints that are the "best" but cost one-quarter as much as most.

Generally speaking, the majority of fleet equipment is refinished and maintained successfully with alkyd undercoats and enamels. Where corrosive materials are handled, more chemically resistant materials are required such as vinyls, epoxies, or chlorinated rubber.

To Order Paper No. 115T . . . on which this article is based, see p. 6.

High Strength Materials—Hot Sizing Them Is Tricky

Based on report by secretary

C. O. COFFER
Ryan Aeronautical Co.

SEVERAL major factors influence the ability to hot size high-strength materials. They are:

1. Creep resistance or compressive strength of the material at elevated temperatures.
2. Pressure applied to the part.
3. Soak time.
4. Thermal expansion of the material.
5. Transformation growth.
6. Accuracy and design of tooling.
7. Tooling materials.
8. Employee techniques.

Serving on the panel which developed the information in this article, in addition to the panel secretary were: chairman **A. L. Smith**, Ryan Aeronautical Co.; **F. J. Peterson**, North American Aviation, Inc.; **J. W. Chambers**, Mar-

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quardt Corp.; and **L. J. Hull**, Ryan Aeronautical Co.

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Road Rating Fuels At Part Throttle

Based on paper by

J. C. Ellis,
Shell Oil Co.

W. F. Ford,
Continental Oid Co.

E. H. Scott,
Standard Oil Co. (Ohio)

and

G. W. Stanke,
Ethyl Corp.

TESTS have shown fuel ratings relative to primary reference fuels to decrease rapidly with increasing part-throttle manifold vacuum. And a decrease in engine octane-number requirements is also experienced under similar conditions.

The fuel rating results were obtained with four makes of cars. The low sensitivity fuels RMFD-80-57 and RMFD-97-58 rated somewhat higher than the other fuels. These fuels were both

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Table 1 — Approximate Decreases in Octane-Number Rating for 1500-RPM Speed Increase

Fuels	Octane-Number Decrease	
	Max Throttle	Part Throttle (12 In. of Hg)
RMFD-80-57, RMFD-97-58	0.8	2.4
Blend 11-C-58, RMFD-83-57	3.2	4.5

Table 2 — Octane-Number Decrease from Maximum Throttle to 12 In. of Hg Manifold Vacuum

Fuels	Octane-Number Decrease	
	200 Rpm	3000 Rpm
RMFD-80-57, RMFD-97-58	4.0	6.8
Blend 11-C-58, RMFD-83-57	8.0	9.5

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about 99 Research octane number, 7 sensitivity, and had olefin content of less than 4%. Similarly, blend 11-C-58 and RMFD 83-57 always rated lowest in the group. These fuels were approximately 98.5 octane number, 10.5–11.1 sensitivity and had over 25% olefins.

Going from 1500 to 3000 rpm gave the approximate decreases in octane number rating shown in Table 1.

Manifold vacuum has a greater influence on fuel ratings than engine speed. Going from maximum throttle to 12 in. of Hg manifold vacuum gave the decreases in octane-number ratings shown in Table 2.

The large octane-number decreases of the more sensitive fuels at 12 in. of Hg manifold vacuum means that a car having a 97-octane requirement at maximum throttle on primary reference fuels must have its requirement decreased at least this amount to avoid part-throttle knock with these fuels. Fuel RMFD-97-58 was the most sensitive fuel tested. Changes in its ratings with increasing engine speed and manifold vacuum are less than blend 11-C-58 or RMFD-83-57. The high aromatic (47%) and relatively low olefin (18%) content of this fuel may have contributed to the better response.

Road Octane-Number Depreciation

Two engine variables and two fuel properties contributed to the depreciation (Research minus road octane number) of the fuels rated in this test. Analysis was limited to four variables, but others may have contributed. The four variables are: engine rpm, manifold vacuum (in. of Hg), sensitivity, and per cent olefins. From a plot of the average rating for each fuel in all cars, the following conclusions were drawn:

1. Increased sensitivity increased depreciation at all engine speeds and throttle openings.

2. Increased manifold vacuum increased the effect of sensitivity on depreciation.

3. Increased engine speed increased the effect of sensitivity on depreciation.

4. Increased engine speeds generally increase depreciation of a given fuel.

5. Increased manifold vacuum increased depreciation of a given fuel.

6. Test fuels which showed the greatest depreciation between full- and part-throttle ratings had the highest sensitivity and highest olefin content.

While part-throttle knock was generally not a severe problem in the cars used in this test program, some cars operating on some fuels did have critical knocking areas at manifold vacuums above 10 in. of Hg. (Based on a report of the Road Test Group of the CRC Motor Committee.)

To Order Paper No. 128V . . . on which this article is based, see p. 6.

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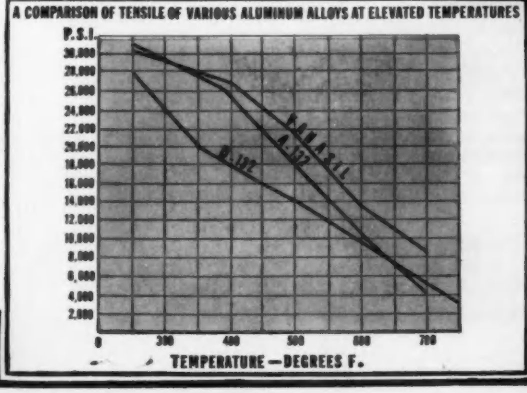

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Briefs of SAE PAPERS

continued from p. 6

of missile or rocket propulsion system; extracts from vibration test specification for Vanguard satellite.

Methods of Estimation in Vibration and Shock Problems, C. T. MOLLOY. Paper No. 100W. Reference made to work of SAE Committee G-5, For Shock and Vibration on Missiles and Aircraft in developing procedures for design of mounting systems for electronic equipment on aircraft; types of information required to carry out calculations described in these procedures; particular quantities are identified and indication given of how they may be estimated prior to measurement.

Investigation of Resonance-Free Vibration Isolation System, G. H. KLEIN. Paper No. 100Z. It is shown that almost resonance-free vibration isolation system, called "Dynamic Isolation System," can be constructed by extending theory of damped dynamic vibration absorber; its application to damped spring-mass system such as airborne electronic equipment in missile field mounted on vibration isolators is analyzed and practical applications are presented.

Progress Report — SAE Subcommittee on Reliability, F. D. APPLEGATE. Paper No. 101T. Scope of subcommittee formed by SAE's Aircraft and Aircraft Powerplant Activity Committees involves exchange information on organizational structure covering reliability activities of contractor through phases of conception, detail design, development, production, and customer or service use; outline of organizational structure required by major weapon system contractor; replies from 10 companies are summarized to describe typical organization covering various areas.

Design for Reliability, B. B. RICHARDSON. Paper No. 101U. Approach taken by Norair Div., Northrop Corp. is demonstrated by examples of component and system redesign of SM-62A, "Snark" missile fuel system; "Ten Commandments for Design Reliability" are outlined which are observed during all phases of design, and during maintenance period review of basic design criteria is made; review of redesign of SM-62A "SNARK" fuel system relative to these commandments is outlined.

Flight Vehicle Power, R. A. JONES, J. S. KEELER. Paper No. 105U. Problem area considered is that of furnishing power outside earth's atmosphere for all vehicle purposes except propulsion, but including power for electric thrust; energy conversion methods for generation of electrical power; anticipated power requirements for boost glide vehicle, short and long duration satellite power; theoretical limits and attainable efficiencies of energy conversion devices: batteries; fuel cells; chemical dynamic systems; nuclear power systems; solar power systems.

Basic Structures for Air Launched Missiles, R. H. LOUGHRAN, L. A. NELSON. Paper No. 106U. Structures are examined from standpoint of their requirements and characteristics as compared to other missile types; analysis considers cost to launching aircraft, effect on missile prelaunch weight, and effectiveness of thermal lag in reducing missile structural weight; it is concluded that increase of performance and mass ratio requires reduction of percent structural weight; for short flight time missiles, reinforced plastic external structure appears promising.

Properties of Asbestos Reinforced Laminates at Elevated Temperatures, N. E. WHAL. Paper No. 106V. Results obtained at Cornell Aeronautical Laboratory in study of composite materials to develop high strength, low density material for use in missile bodies, nose cones or combustion chambers of rocket motors; study of asbestos composites and test results obtained with long fibered chrysotile asbestos fibers used as reinforcement for heat resistant, phenolic or silicone resins; silicone asbestos laminates maintain high percentage of their mechanical properties up to 800 F and should be considered.

Radiation Effects Studies for Development of Radiation-Resistant Aircraft Subsystems, J. J. TIERNEY. Paper No. 107T. Problems of operating aircraft

continued on p. 130

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continued from p. 130

equipment in radiation environment of nuclear-powered aircraft and studies being performed in effort to produce radiation-resistant aircraft subsystems; basic considerations of radiation environment and its interaction with matter; radiation effects on and resultant damage to materials and accessories; Convair program to develop radiation resistant subsystems.

Convair's B-58 Cyclic Fatigue Certification Program, C. D. LITTLE. Paper No. 108U. Summary of program for B-58 supersonic bomber consisting of development of load spectra, preparation of fatigue analyses, development of test load spectra, fatigue tests of components, and complete airframe, and flight data gathering programs.

Hgh Temperature Pneumatic Actuators, W. J. KOERNER. Paper No. 107U. Limitations of hydraulics and advantages of pneumatic actuation systems; developments in pneumatics are summarized with respect to system stability techniques and methods of overcoming low bulk modulus; positive displacement air motors capable of sustained operation at high temperatures and development of high temperature materials; construction features of air motor actuator under development by Marquardt Corp. designed for use in 1200 F direct ram air system.

Prediction of Aircraft Wing Gust Fatigue Damage by Means of Power Spectral Analysis and Constant Life Curves, R. H. GAMES. Paper No. 108W. Problem of gust induced fatigue in military aircraft structures; method is presented which predicts aircraft wing experience in terms of oscillatory bending moment; also method of developing representation of wing fatigue characteristics in form of constant life curves; example considered is concerned with effects of gust loading and aircraft wing response for altitude of sea level and flight speed of 550 knots.

Year of Jet Operation Experience at New York International Airport, T. M. SULLIVAN. Paper No. 109T. Problems posed to airport operator arising principally from noise, jet blast, size and type of fuel; summary of experience gained, measurements taken and policy observed by Port Authority with regard to these areas; provision of new instrument runway and its outstanding features; future developments.

Ground Support and Handling of Jet Aircraft, G. W. McKENZIE. Paper No. 109U. Review of steps taken by Trans World Airlines, Inc., in early planning; philosophy employed in certain TWA decisions, and experience to date in support of jet aircraft; selection of 140-kva 400-cycle a-c truck-mounted diesel-driven unit adequate for ground operation of airborne electric freon air conditioning packages; towing and starting equipment; development program underway on preloaded baggage and cargo handling system.

Development and Application of Fatigue Analysis to Aircraft Fasteners, J.

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L. CHINN. **Paper No. 108T.** History of aircraft fastener fatigue testing and effort made in developing standardized test methods, fixtures and equipment; features covered by Specification NAS-1069 relating to fatigue test machines, specimen holding fixtures, standard test loads and conditions, etc; use of fatigue test in quality control, and evaluation of materials; comparative evaluation of titanium and steel fasteners; developments in methods and flight incidents resulting from system or component malfunction.

Boeing 707 in Service, R. M. MORGAN. Paper No. 110T. Review of pre-delivery improvement program and present effort on current problems of similar nature, made by Boeing Airplane Co. in developing 707; some changes resulting from program to realize design and performance improvements are outlined; summary of post-delivery experience relating to three groups of troubles, inadvertent flight maneuvers, system problems, and flight incident resulting from system or component malfunction.

Development and Operation of Lockheed Electra, R. W. PARTRIDGE, V. S. UPTON, J. T. POWER. Paper No. 110U. Program involved in simultaneous design, development and production of Electra; salient design features and examination of operation since its introduction into service; design parameters of 400-mph transport aircraft for short to medium range flights, powered by four Allison 501-D13 engines producing 3750 eshp; supporting programs required; ground handling; air conditioning, electrical, hydraulic and surface control booster systems; fuel system and other features.

First Year of Jet Age-Reflections, F. W. KOLK. Paper No. 110V. Monte Carlo method is applied by American Airlines, in calculating scheduling system which takes in account payloads and flight times, environmental conditions and other factors of significance in conduct of flight; baggage expediter system, mechanical reliability of vehicle, operating problems; problem of community noise.

Preliminary Design Considerations for Structure of Trisonic Transport, M. G. CHILDERS. Paper No. 111T. Problems facing structure engineer in design of Mach 3 transport such as Boeing 707, Douglas DC-8, and Lockheed Electra; problems relate generally to aerodynamic heating, high altitude, and thin shapes inherent with this type; structural design parameters, weight ratio, materials, structural configuration, fuselage, etc.

Automatic Navigation for Supersonic Transports, R. F. MILLER. Paper No. 111U. Background of navigation prob-

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lem and possible solution through automatic inertial navigation, originally developed for guidance of strategic missiles and space vehicles; self-contained system using dynamic measurements as source of continuously available position and velocity data is not susceptible to error induced by distortion of magnetic fields, nor to loss of contact under adverse ionospheric conditions; effect of inertial navigation on pilot's function and availability of equipment.

Doppler-Inertial Navigation for High Performance Aircraft, L. S. REEL. Paper No. 111V. Methods presently used to obtain flight control information in subsonic aircraft and their shortcomings when applied to supersonic environment; analysis of instrumentation requirements; details of Doppler-inertial system, developed by Ryan Aeronautical Co. to fulfill requirements of supersonic jet transport; system includes Doppler, inertial, digital, and readout equipment.

Effect of Properties of Materials for 1000 F Motors on Design Voltage for Optimum Specific Output, E. A. LINKE. Paper No. 112T. Approach taken by Airborne Accessories Corp. in developing small 3-phase motors for aircraft and missile power equipment operating at high temperature; size and weight of motor, for given specific output, varies with saturation flux density of magnetic core; winding space factor, and conductivity of winding; factors to consider in selection of optimum voltage.

Development and Testing of High Temperature Bearings, R. T. WESTMORELAND, P. J. HANIFIN. Paper No. 112U. Program directed to provide 2×7 in. self-aligning, antifriction bearings capable of operating in temperature environments ranging to 800 and 1500 F for supporting control surfaces of North American's Navaho missile system; test material selection and use of Brayco No. 483 oil (per MIL-C-6529A) lubricant which dissipates at higher temperatures without harmful residue to impair operation of bearing; testing procedures for manufacturing titanium carbide bearings.

Dulles International Airport, HERBERT H. HOWELL. Paper No. S216. Describes new international airport being planned for Washington, D. C., area to be located near Chantilly, Va. Covers layout, land acquisition, community relations, initial construction, mobile lounges, and access highway.

Problems of Space Exploration, W. H. SCOTT. Paper No. S208. Summarizes information currently available to engineers in connection with problems of higher mass ratios, larger rocket engines, higher fuel specific impulses, and new materials and techniques for reentry of space vehicles. States these problems are just as basic to space flight as are lift-drag ratio, specific fuel consumption, and structural weights to flight in atmosphere. To illustrate, a typical flight plan is fol-

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lowed for a space flight, starting with the launch and exit from the earth's atmosphere and ending with the return to earth.

FUELS & LUBRICANTS

Turbine Fuel Thermal Stability — CFR Coker and Flight Evaluations, J. D. ROGERS, JR. Paper No. 103T. Report of Fuel Thermal Stability Group of Coordinating Research Council, Inc. presents results of study of research methods for determining stability threshold temperature of jet fuels; correlations of standard CFR fuel coker results, flight tests, and service experience; research techniques used to explore stability of fuels at bulk temperatures above 500 F. 23 refs.

GROUND VEHICLES

Dynamic Balancing of Engine/Clutch Combinations, M. G. AVERY. Paper No. 114U. Problem of unbalance at modern engine speeds in truck engines; examples of effects of unbalance; controls exercised by manufacturer to limit unbalance in two different and popular engines; control in field.

Role of Surface Coatings in Fleet Maintenance, R. L. SEARS. Paper No. 115T. Selection and application of paint coatings for corrosion protection of commercial vehicles.

Good Design, Good Maintenance — Corrosion Free Life, W. C. WELTMAN, Jr., N. A. BAST. Paper No. 115U. Factors to consider when designing aluminum structures for motor vehicles; choice of material from strain hardened or heat treated alloys; steps in prevention of corrosion because of dissimilar metal contact; importance of planned maintenance program.

Fleet Operator's Views on Corrosion, D. K. WILSON. Paper No. 115V. Corrosion experiences of fleet serving gas and electric public utility operating in New York State described and illustrated; experience of operators in other areas; no effective protection method devised yet; successful method of repair after damage developed.

IH High-Speed Lightweight Diesels, A. F. DEWSBERRY, C. P. BOZOS, J. B. REEVES, JR. Paper No. 116T. New line developed by International Harvester consists of four 6-cyl engines covering range from 20 to 100 hp; engines are not only modern tractor engines, but versatile power packages for many applications; principal approach in design was to adapt existing truck engine to diesel combustion; details of crankshaft and bearings, crankcase, piston and connecting rod, etc; 12-v glow plugs located in each precombustion chamber used instead of integral gasoline starting system; performance data; turbocharger.

Brake Drums — Investment for Safety and Profit, P. G. HYKES, C. A. HERMAN. Paper No. 117T. Elements involved in brake drum design and testing are discussed; rating of vehicle brakes and brake drums; thermal and power considerations; brake drum design and materials; testing.

Economics of Heavy Duty Brake Design and Maintenance, R. K. SUPER. Paper No. 117U. Review of design and operational problems; further elaboration of eight points previously agreed upon concerning phase of problem regarding extended brake service life and periods between brake adjustments; maintenance practices which can strongly influence ultimate results.

New Hercules Polydiesel Engines, E. A. V. HORIAK. Paper No. 118T. Improved version of Hercules turbulence chamber engine; new system developed that makes engine run smoothly with minimum of diesel knock and also makes it possible to refine engine so that its fuel consumption matches that of open chamber diesel engines; this economy is obtained with auxiliary chamber inside cylinder head where spray pattern has only minor importance and where pintle type self-cleaning fuel nozzles are used; D-426 6-cyl in line and Dv-662 Vee 8-cyl polydiesel

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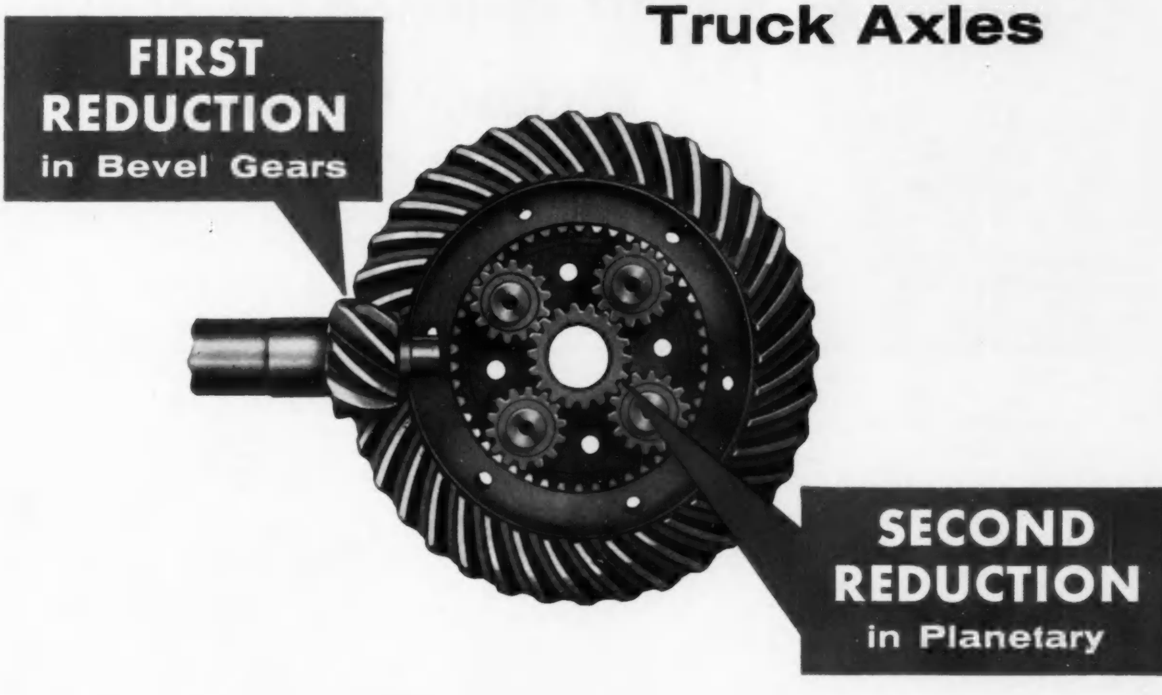
A New Concept in Double Reduction Truck Axles



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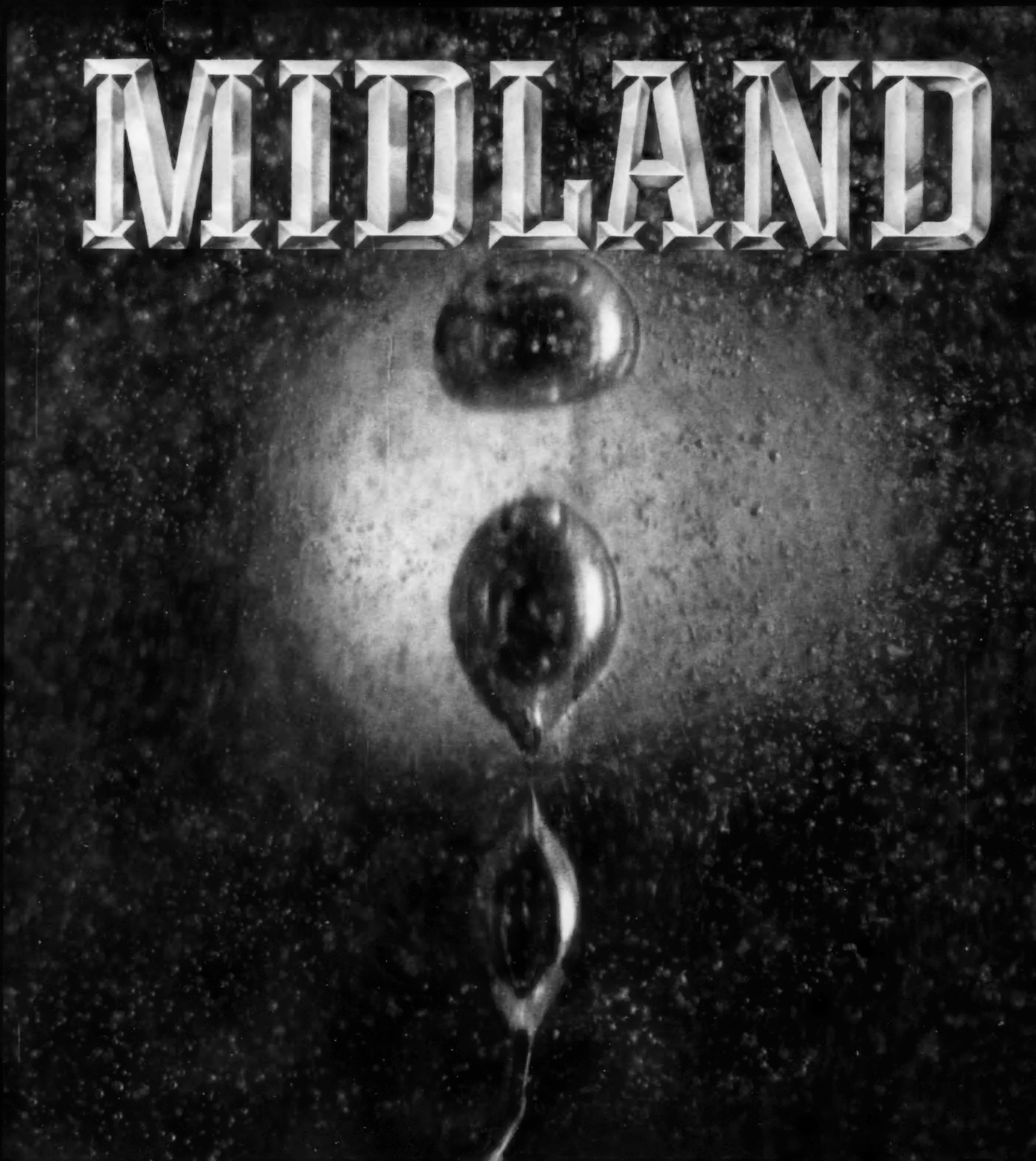
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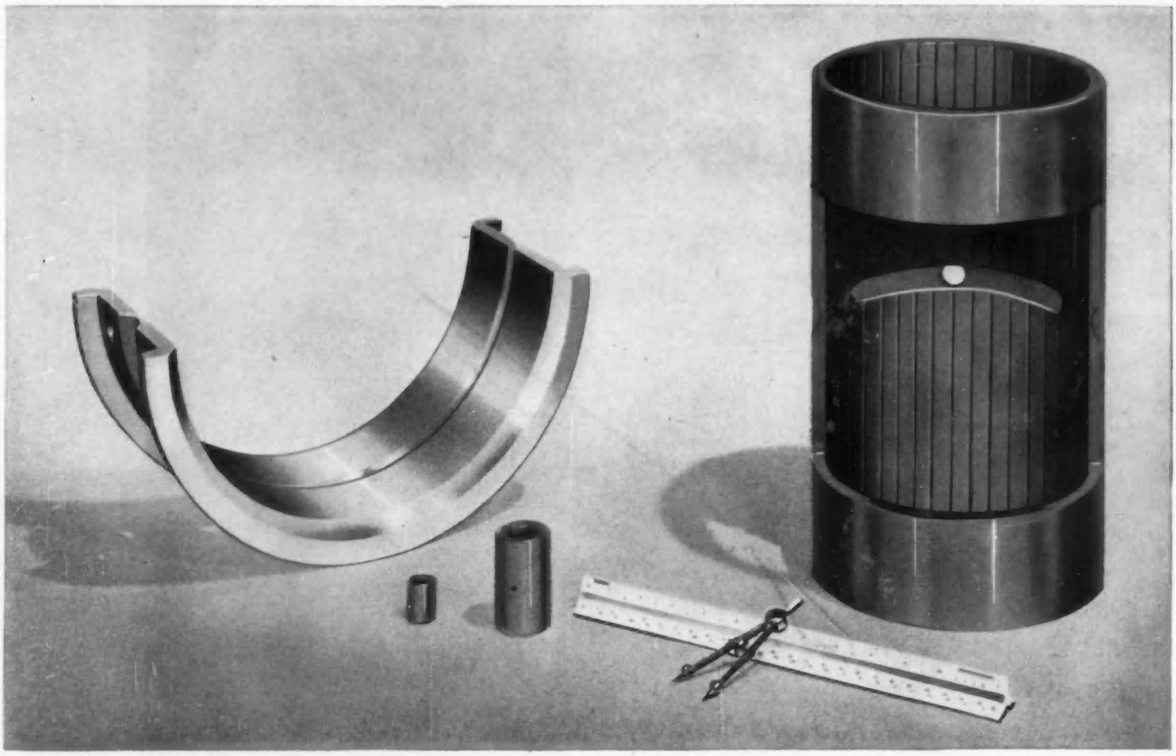

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engines now produced by Hercules Motors Corp.

Road Performance of Comprex Supercharged Diesel Truck, M. BERCHTOLD, H. P. GULL. Paper No. 118U. Road performance with Comprex supercharged White Truck Model 9000 with Cummins JT-6 engine reported; Comprex delivers high air density over wide engine speed range, and responds immediately to load changes; principle of operation; Comprex calibration; design description; vehicle diesel engine; sea level and altitude performance; improved matching in view of altitude performance; control system; truck installation.

Dynamic Balancing of Rebuilt Engines and Driveline Components, R. T. BUSCARELLO. Paper No. 114T. Principles of static, kinetic and dynamic balancing; difference between commercial and precision balancing; balancing pistons and connecting rods; balance tolerance for rotating parts; causes of dynamic, or combination of kinetic and dynamic unbalance; balancing drivelines; balance tolerance for "flexible rotors; effects of critical speeds or resonance; use of portable balancer and its advantages for maintenance work; when to use cradle balancer.

More Miles per Gallon for Big Cars, too, PAUL C. ACKERMAN. Paper No. S223. Claims fuel economy of 1960 Plymouth 6 is better than that of 1940 model, despite larger car size, greater horsepower, and addition of more accessories. Points to engine improvements that have made this possible. Discusses problems of improving econ--omy. Stresses importance of good driving techniques in obtaining highest mpg.

Handling Requirements, O. J. WINKELMANN. Paper No. S220. Examines handling behavior of passenger cars, and what makes a car handle well, particularly cornering ability, directional stability, wind stability, response, and feedback.

Ride Requirements, R. SCHILLING. Paper No. S219. Analysis of passenger-car ride problem, methods of improving conventional suspensions without introducing new elements, and why many arrangements are not commercially successful.

Future High Angle Joints, D. P. MARQUIS. Paper No. S218. Past, present, and future of universal joints. Describes variety of joints designed to overcome main deficiencies of basic universals joints: velocity variation and bending couples. Concentrates on so-called high angle joints, which are designed to transmit torque through 6-25-deg included angle, at speeds up to 5000–6000 rpm.

Canadian Developments in New Bus Design, A. E. Jennings. Paper No. S214. Describes new design of 43-passenger transit bus especially developed

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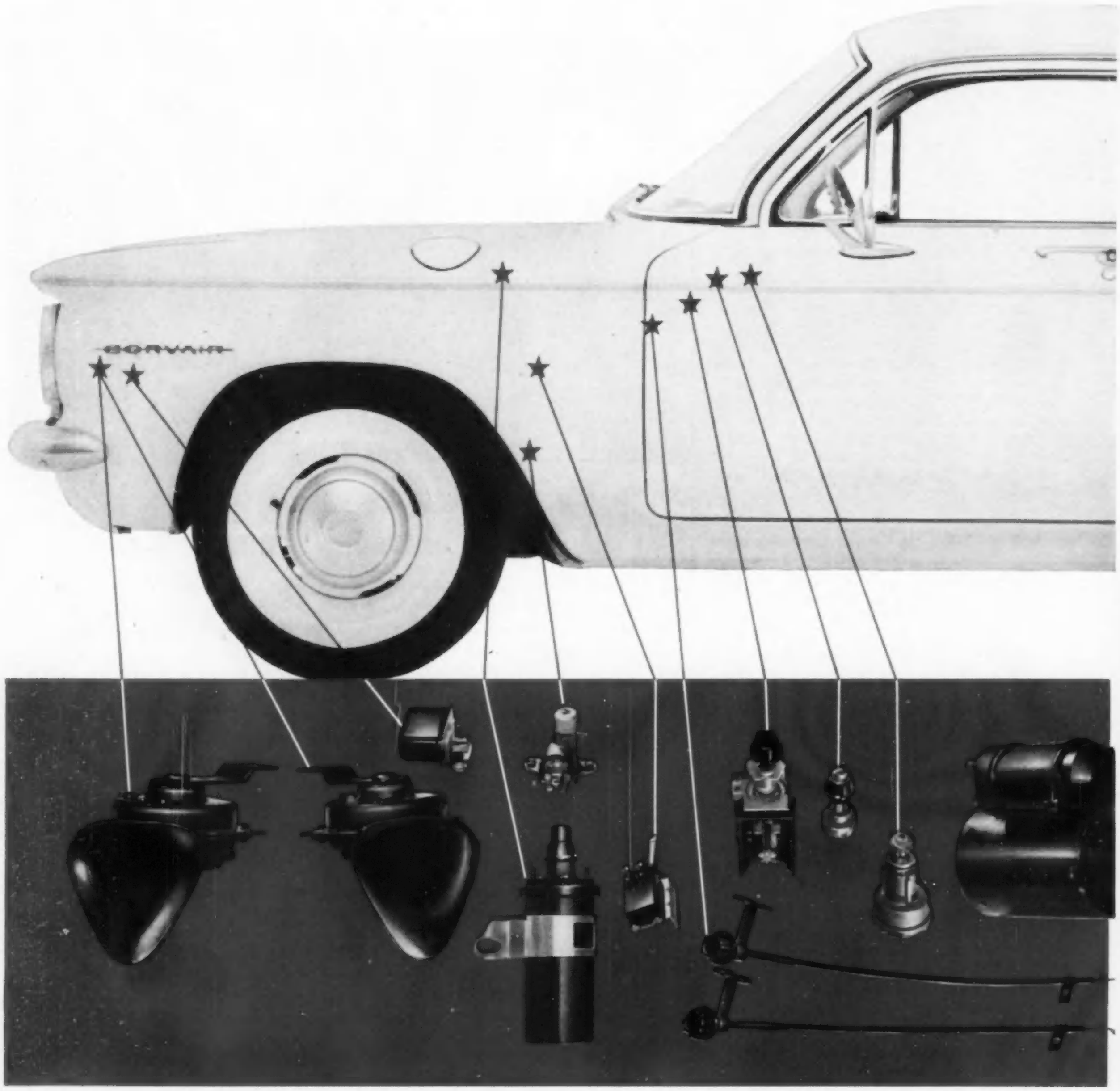

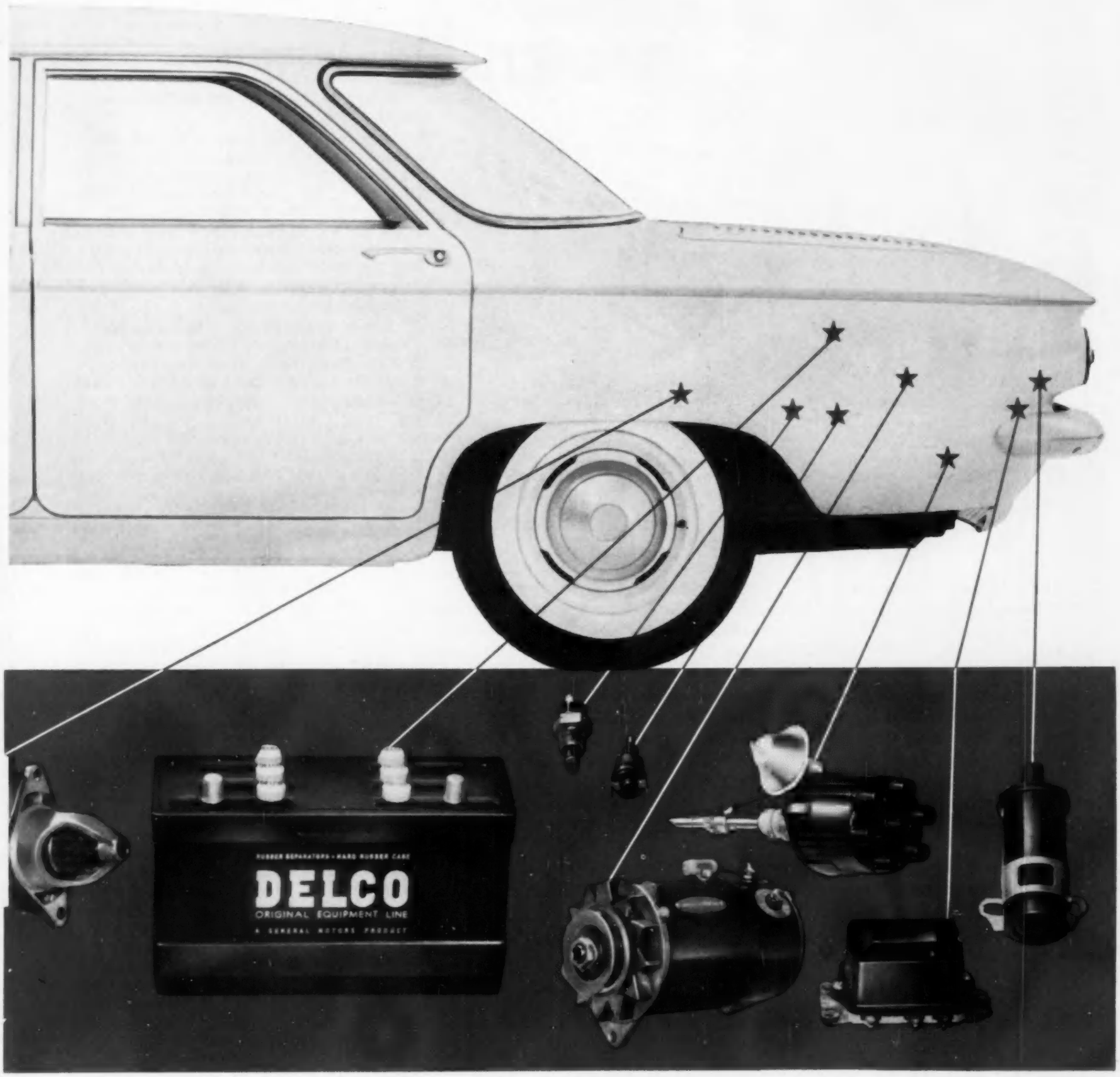
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for Canadian operators; including body construction, windows, heating and ventilation, seating, doors, engine, and air suspension.

Control of Exhaust System Corrosion, TOM DANNER. Paper No. S212. Discusses factors affecting muffler and exhaust system life, including widespread use of dual exhaust systems; methods of control corrosion rate in exhaust system parts, such as muffler design and materials.

Impact of Compacts, HOLGER RIDDER. Paper No. S206. Does the American motorist want compact cars? If so, how badly; and how many will he buy? Extent to which they succeed in the market will determine their impact on the service field and the oil industry in general. General specifications for Corvair, Valiant, Falcon, Lark, and Rambler are given.

Ausco Truck Brake — Retarder Combination, D. A. GOTSCH. Paper No. S207. Describes a truck brake-retarder combination produced by Auto Specialties Mfg. Co. In the combination is an oil-cooled multiple-disc brake which is used for service braking and retarding. The brake is fully sealed and full of cooling oil at all times. Heat generated during braking and retarding is rejected to the engine radiator through a separate brake oil cooling system.

Influence of User on Vehicle Design, CARROLL W. BOYCE. Paper No. S209. Challenging comments on current truck design, from the standpoint of an industrial engineer who now is the editor of a truck fleet magazine.

How Good Is Testing? WILLIAM A. McCONNELL. Paper No. S210. Describes a method of validating proving ground test routines as a sample of customer operations. Comparisons of field survey and proving ground failure statistics as regards a group of passenger cars are analyzed to establish sample reliability and severity ratios. Alternative means of accelerating the test program are considered, with examples indicating the effect on correlation.

Fuel-Injection Equipment for Multifuel Engines, HANS HOGEMAN. Paper No. S221. Analyzes problems in development and operation of successful multifuel engines, and indicates the lines of progress as regards injection pump design, nozzles and holders, manifold pressure compensating devices, and many other features. Says multifuel engine is currently of interest only to the military, but points to potentials for commercial applications.

Installation Status of Gas Turbine Engines, R. L. STODDARD and R. H. HARRISON. Paper No. S217. Description of the gas turbine for automotive uses first developed in 1949 by Boeing Airplane Co. for the U. S. Navy. Brings to date information on operating and manufacturing experience since that time, including data on performance, fuel economy, cost of manu-

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facture, etc. Applications listed include mine sweeping generator drives; small boat propulsion; earthmoving equipment propulsion; truck propulsion; pump drives; towing vehicle propulsion; airplane, helicopter and target-drone propulsion; aircraft engine starters; and small railway-switch-engine propulsion.

General Discussion of Safety Regulations and Proposed Revisions, MARVIN W. VAN CLEAVE. Paper No. S213. Discussion of laws from which ICC derives its authority to administer and enforce Motor Carrier Safety Regulations; also present safety regulations and some of changes being proposed — and reasons for the proposed changes.

PRODUCTION

High Quality Structural 17-4PH Castings, W. R. ROSER, K. E. KUSCHELL. Paper No. 104V. Use of investment castings as prime structural components by Northrop Corp. in producing T-38 "Talon" supersonic jet trainer; study of causes for brittle fractures of 17-4PH steel castings showed presence of microshrinkage and large amounts of dendritic shaped ferrite are major causes of low ductility and resultant rejection of 17-4PH castings; it is found that retarding cooling rate of mold minimizes microshrinkage, reduces ferrite content, and reshapes ferrite.

Development of New Extruding Techniques for Pure Beryllium and High Temperature Steel, L. M. CHRISTENSEN. Paper No. 98U. Mid-term progress report of 2-yr program undertaken by Northrop Corp., Norair Div.; programs are predicated on airframe and extrusion industry survey followed by competitive development of same shape by more than one extruder; materials selected for Phase I extrusion development are H-11" grade (5% chromium hot work die steel) and "A-286" temperature resistant ferrous alloy; results of investigation; feasibility of bare beryllium extrusion and future work.

Development of High-Temperature Thermocouple-Materials, R. C. LEVER. Paper No. 105V. Compilation of thermocouple systems and metallic elements having melting temperatures above 1400 C, comprising base, refractory, and noble metals; desirable properties for ideal thermoelectric combination of materials; possibility of extending usefulness of thermocouples by development of noble metal thermoelements possessing important combination of improved thermoelectric output, measurement of high temperature and superior stability.

New Techniques for Production Flexibility, C. J. KARRER. Paper No. S215. Describes some new production techniques developed by Detroit Diesel to provide for production flexibility in manufacture of their many models of diesels. Specifically, highly versatile production machinery and maximum interchangeability of engine parts were results of cooperative program.

ALSO AVAILABLE

1959 SAE AIRCRAFT MANUFACTURING FORUM . . . SP-329 consists of reports on 16 panels, as follows:

Missile Support Equipment, reported by A. O. DORITY, secretary. Discusses solid- and liquid-propellant missiles. Outlined are integrated factory-to-field test concepts; handling and transportation of large rockets; field check and countdown concepts for solid boost missiles; assembly problems; cryogenic aspects of propellant handling; and testing of support systems and components.

Materials and Processing Controls of Modern Alloys, reported by WILLIAM GRAY, secretary. A closer association between manufacturing and quality control is becoming a necessity to establish in-process controls and maintain adequate records to assure the correct processed condition for the modern alloys. Examines the reliability of materials; heat treatment; welding; and manufacturing systems.

Shear Forming, reported by L. W. GREEN, secretary. Examines fields of application; the importance of metallurgical control related to this process; the state-of-the-art of tooling and methods for this process; the impor-

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continued from p. 148

tance of the equipment requirements; and the probabilities for the future.

Achievement of Product Reliability, reported by C. M. VOLKER, secretary. Organizational and functional aspects and the impact of reliability at the factory level. Product and production improvement through reliability.

High Temperature Sandwich Construction, reported by W. F. ROBERTS, secretary. Examines merits of brazed honeycomb sandwich and welded steel sandwich. Discusses methods of brazing sandwich panels and inspection and quality control in the brazing and welding process.

Facilities Planning and Maintenance of New Equipment, reported by H. A. SICHLER, secretary. Discusses how to communicate both facilities and funding requirements to management; advantages and disadvantages of "skills-type" and "area-type" of maintenance organization; and methods of training maintenance personnel for the entirely new concept of maintenance operations brought about by the increasing complexity of automatic machines.

Control of Manufacturing Costs, reported by J. A. SIMPSON, secretary. Discusses master schedule programming; parts supply controls; material cost controls; and role of data processing in cost control.

Control of Change Cost, reported by R. L. WORTHINGTON, secretary. Discusses effects of manufacturing changes on costs; effects of engineering changes on costs; and the action financial management takes in the control of changes and their costs.

Handling of Propellants and Gases in Airplane and Missile Manufacturing, reported by L. D. WEBER, secretary. Gives brief summary of the range of propellants and gases; physical and chemical properties; safety techniques in handling; warehousing and transportation considerations; and, training considerations.

Materials Handling, reported by H. S. COOPER, secretary. Tells what's new in materials handling with emphasis on work-in-process materials handling methods. Also covers how expensive materials handling is, and how it affects reliability.

Hot Forming and Sizing of High Temperature Alloys, reported by R. DOBSON, secretary. Gives methods, tooling, advantages and disadvantages of: Hot sizing of Rene 41, 17-7PH, PH 15-7 Mo; hot forming methods for HK 31, HM 21, molybdenum, Hasteloy; and hot forming of titanium and titanium alloys.

Missile Rocket Case and Pressure Vessel Manufacturing, reported by E. L. STONE, secretary. Examines solid propellant case requirements that affect the manufacturing processes; tooling for large diameter thin wall pressure vessels;and the manufacture of rocket cases and pressure vessels from structural plastics. Also covers the sizing process as a dimensional control

continued on p. 152

HEAVY-DUTY

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FOR HEAVY-DUTY OFF-HIGHWAY EQUIPMENT . . .

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Brake Division, Ashtabula, Ohio

continued from p. 150

in rocket case manufacture, and the control of rocket case and pressure vessel dimensions in heat treatment.

Optics in Production, reported by J. RYAN, secretary. Investigates optics as an aid to engineering and production; use of auto-collimation; and the use of optics instead of tooling.

Operations Research in Manufacturing Decisions, reported by H. W. WHITE, secretary. Covers production scheduling and control, machine shop simulation, production lot sizes, and manpower loading. Analyzes an actual tool crib problem.

High Temperature Coatings, reported by H. W. INGALLS, secretary. Examines ceramic, cermet, and metallic coatings for applications up to 2300 F; pack vapor phase high temperature coatings; reinforced ceramic insulating and refractory metal coatings; flame ceramic-materials properties and uses. Also discusses high temperature coatings and applications to high speed vehicles; flame sprayed refractory metal and refractory ceramic coatings for thermal insulation, oxidation, and erosion protection; and, ablation materials systems properties, design factors, and methods of quantitative comparison of one system with another.

Electronic Production, reported by DON YOST, secretary. Looks at electronic designs of the future, the manufacture of electronic components and systems, and automation as applied to current and planned electronic manufacturing. Reveals the impact of the new generation of electronic designs on automatic methods.

New Members Qualified

These applicants qualified for admission to the Society between December 10, 1959 and January 10, 1960. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Atlanta Section

Daniel L. Enfield (J).

Buffalo Section

Sheridan D. Smith (M).

Central Illinois Section

William Lee Brown, Jr. (J), William S. Gripman (M), William R. Hawks (M), Daniel Charles Lenkaitis (J), Alvin W. Montgomery (M), Gene Alan Pfotenhauer (J), Bernard E. Swanson (A), Ralph Tegg, Jr. (J).

Chicago Section

Richard Thomas Bievenue (J), Robert F. Davis (A), Keith H. Fulmer (J), William George Huley (J), Robert Mark Shane (J), Maurice Van Dierendonck (A), Rouholah Zargarpur (M).

Cincinnati Section

Wilton F. Melhorn (M), J. W. Savage (J).

Cleveland Section

Wayne Robert Brown (J), L. J. Campbell (M), Paul Allan Cirino (J), Warren Ervin Fife (J), Michael E. Kastner (J), Morgan Martin (M), Walter F. Mog (J), Lee F. Schiemann (J), James Edward Sheffield (J).

Colorado Group

Lee Edward Anderson (J).

Dayton Section

G. William Beck (M), William V. Kenzik (J), Dale D. Steinke (J).

Detroit Section

Burlin H. Ackles, Jr. (M), Thomas Francis Adams (J), George W. Albright (A), Ivan Angeloff (M), Richard Peter Bialek (J), Charles A. Brethen, Jr. (M), Donald A. Brownson (J), William A. Burmeister (M), Dean M. Chisel (M), Robert F. Dean (M), Robert E. Delderfield (M), William J. Durako (J), Joseph R. Fortier (J), Richard Thomas Geggie (J), Albert J. Gonas (M), John H. Greening (M), Duane Henry Harwick (J), Paul Richard Henry (J), George Franklin Hill (J), J. Edward Kloian (J), Arthur A. Kowalski (J), Donald C. MacDonald (J), Joseph J. Magyar (J), Robert F. McCabe (A), Harold Bruce Meyer (J), Randal Thomas Murphy (J), Norbert A. Nann (J), John R. Nyland (A), Dennis P. Pazuk (M), Burton Allen Pearson (J), Robert T. B. Peirce (A), Fred C. Porter (J), Charles D. Potter (J), Dennis C. Proctor (J), Eugene V. Renaud (A), Gilbert F. Richards (A), Aronld Keith Riddle (J), Daniel J. Sellmeyer (A), Michael D. Sheean (J), Donald Joseph Smithbauer (J), Lawrence J. Vanderberg (M), William B. Williams (J), David Ronald Wilson (J).

Fort Wayne Section

John Raymond Duff (J), Charles F. Powell (J), Bruce D. Sibley (J), Benjamin R. Vian (J), Barrie Lee Wilson (J).

Indiana Section

Thomas Allen Berghoff (J), Morris Esche (J), Benjamin John Holanda (J), William J. Keller, Jr. (J), Keith G. Rochford (J).

Kansas City Section

Clifford G. Cain (M).

Metropolitan Section

Peter Arthur Aron (J), Joseph P. Auffant (A), Anthony J. Carlisi (J), Bruce H. Carpenter (M), Robert H. Foglietta (J), James R. Keegan (A), Wolodymyr E. Kulynycz (J), Richard W. Melosh (M), Kennth L. Myers (A), Thomas A. Pakenham (A), Alexander E. Prunka (A), 2/Lt. Richard J. Pryor, Jr. (J), Robert A. Todd (M), Lawrence M. Tucker (M).

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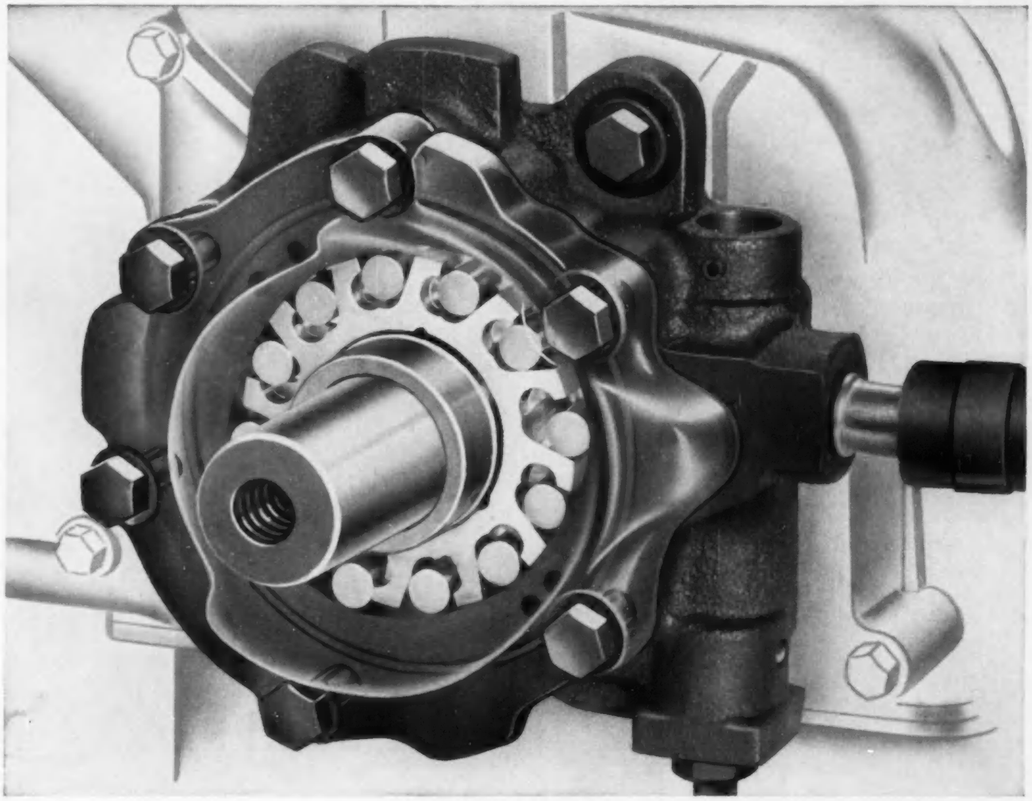
Brake Division, Ashtabula, Ohio

MORE SPACE FOR ACCESSORIES



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By eliminating the need for mounting brackets, pulleys, and v-belts, the Eaton Direct Crankshaft-Driven Power Steering Pump saves valuable under-hood space. The oil reservoir is remotely mounted—out of the way. Direct crankshaft drive provides power for steering under all conditions; eliminates the need for belt adjustments.

The Eaton Crankshaft-Driven Pump is an advanced version of the basic Eaton Roll-Pump design which has been performance-proven in operation on many leading passenger cars, motor trucks, and tractors. High efficiency, dependability, quiet operation, and low cost maintenance are tangible benefits inherent in this design.

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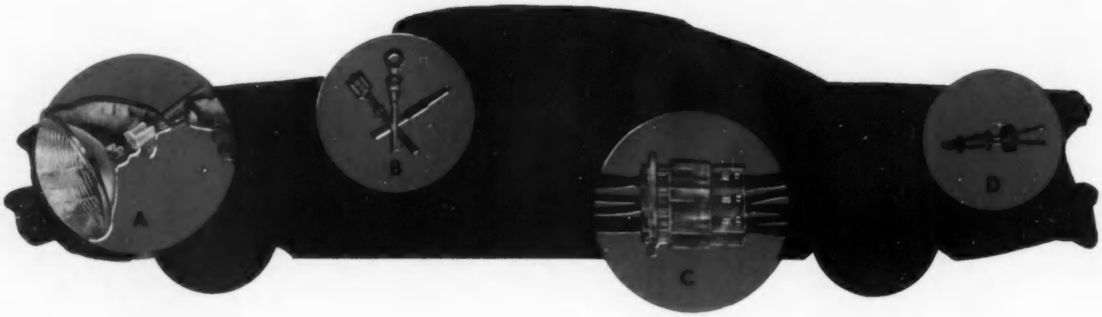

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New Members Qualified

continued from p. 152

Mid-Michigan Section

John Walter Arnold (J), C. Dale Evans (M), Roland John Fernekes (M), John Thomas Herridge (J), Bernard A. Kruszka (J), Larry Ruffle (J).

Milwaukee Section

Donald J. Berchem (J), Kyle Roger Ericson (J), Franklin H. Greb (J), Glen Hodel (J), Donald A. Miller (J), Thomas James Olk (J), Donald Joseph Pribyl (J).

Montreal Section

R. H. Bowden (A).

New England Section

Roger Owen Gagne (J), Robert K. Horne (A).

Northern California Section

Ronald Orville Byram (J), Adrain P. Fioretti (M), Aksel Sigmund Holland (J), Richard L. McManus (A), Frederick W. Miller, III (J), Everett Eugene Spitler (J).

Northwest Section

Milo Duncan Bell (J), John A. Daubenspeck (A), Paul T. Malone (M), Ronald McIrvin (J), Charles Joseph Woodruff (J).

Ontario Section

Ralph Austin Cudmore (A), Michael J. Heuer (J), John P. O'Reilly (J), August Sunnen (M), Lloyd S. Tweedle (A).

Oregon Section

John B. Manin, Jr. (A).

Philadelphia Section

Bernard Richard Bolstad (J), William A. Conway (A), Charles J. Cressman (J), Anthony N. Schmitz (J), James E. Sinderson (A), Richard A. Wirth (M).

Pittsburgh Section

Stewart F. Sonen (J).

Rockford-Beloit Section

Jere G. Castor (M).

St. Louis Section

George A. Coward (J), Jack Wayne Dennis (J).

Salt Lake Group

Robert Jay Wheelwright (J).

San Diego Section

Albert C. Busche, Jr. (M), Robert Alva Farnsworth (J), William H. Gallaher (J), Thomas Adam Krattley (J), Joseph Raymond Timlin (M), Charles Gordon Wolcott (M).

Southern California Section

Fred Arrence Ahle (J), Burnham R. Benner (J), James DeKlotz (M), John S. Fitzpatrick (M), Franklyn B. Floren (M), Carl Holman Grover (A), William Hill Huntington (J), Robert F. Hart (M), Richard C. Keidel (J), William Bruce Lindsay (J), James Norman Locke (J), Finley H. Rhodes (A), Dennis Patrick Ryan (J), Warren H. Sack (J), Lauren H. Welch (A), John Anthony Wentworth (J).

Southern New England Section

David D. Bott (J).

Texas Section

William W. Boyd (M), John Edward Field (J).

Twin City Section

Vernon Paul Castle (M).

Washington Section

James H. Drum (M), Nicholas C. Rouse (J), Kenneth B. Tamai (J).

Western Michigan Section

Roy Edward Schmidt (J).

Wichita Section

L. L. Nighswonger (M), Jerome D. Rader (J), Leonard Harry Reimer (M),

Outside Section Territory

Roland Roy Armstrong (J), Robert Eric Beveridge (J), Stuart Marvon Birley (J), Walter B. Clement (J),

continued on p. 156

New Members Qualified

continued from p. 155

Roger L. Fuetter (M), A. W. Oehler (M), Wayne Louis Peterson (M), Paul R. Smargiassi (J), Myron S. Stacks (J).

Foreign

Yuzo Koga (M), Japan; Tummala Sree Krishna Murty (J), India; Jon Prietz (J), Sweden; S. Shanmugasundaram (M), India; Ian E. Webber (J), South Australia; Luigi Zandona (M), Italy.

Applications Received

The applications for membership received between December 10, 1959 and January 10, 1960 are listed below.

Atlanta Section

James H. Reynolds, B. Anthony Stevens

British Columbia Section

Wilbert Watson, Warren D. Woodburn

Central Illinois Section

Alan H. Olinger, Alfred H. Thoman, Jr., John C. Thompson, Colin Ernest Woodley

Chicago Section

Eugene S. Baranowski, Charles M. Barnes, George A. Berry, III, Marvin John Carlson, Philip E. Cary, Francis L. Foley, Ted Havenar, Arthur E. Nelson, James F. Sauer, Victor P. Vidugiris, Joseph J. Rokos, John Schmidt, Ralph E. Ulm

Cincinnati Section

A. F. Schexnayder, Karl G. Sommer

Cleveland Section

George B. Howell, James A. McGowan David H. Roberts, Frank Van Syckle Smith, Jr.

Colorado Group

Bruce H. Gale, Harry A. Lane

Dayton Section

Albert T. Hart, Robert A. Manogue, Vernon L. Pickering, William E. Thomas

Detroit Section

Paul B. Appeldoorn, Roy W. Best, J. Richard Bohn, Jr., Charles J. DeLorean, Jerome John Frankowski, Donald P. Haseltine, Leslie Hamilton Klauer, Morris Kosten, LaVerne M. Krieger, Harold A. Maloney, LeRoy David Matthews, Ronald M. McIndoe, Robert E. McMaken, Donald E. McMinn, James G. Musser, Jr., George F. Owens, James S. Owens, Richard P. Paulis, Guy Donald Pierce, Robert Fullington Rea, Lloyd E. A. Reuss, John Serbin, Brent D. Sherman, David A. Sloss, Jr., Dean E. Smith, Jr., Robert William Warnke

Fort Wayne Section

Robert O. Baker

Hawaii Section

Seichi Kato

Indiana Section

Stanley Davis, James L. Hoch

Metropolitan Section

Edward E. Carter, Kent Ransom Costikyan, Jr., Richard J. DeChard, Albert G. Feil, Edward D. Hook, William B. Hungerford, Arthur J. Kelly, John B. Littlefield, Gerold F. Schlager, Oliver A. Servadio, Charles Stahley, Martin Sweitzer, Michael J. Walsh, Robert C. Ward, Stephen F. Wilder

New England Section

Harold F. Roth

Northern California Section

Lewis C. Coffey, Walter H. Westerback

Northwest Section

James E. Tomlin

Ontario Section

Frank William Baker, George S. Clark, Kenneth R. Coulter, Franklin H. Cressman, G. L. Felix

Philadelphia Section

Francois Ernest Didot, Michel Gochtovtt, Albert Cooper Littlejohn, Robert H. Sinnamon, W. W. Tilden

Rockford-Beloit Section

Delmer L. Rench

St. Louis Section

James L. Martin

Southern California Section

Robert R. Breshears, James B. Gregory, Hal C. Huffman, Michael S. Patitucci, William L. Rose, Edward G. Rowlett, Henry Wilson Styers

Southern New England Section

William H. Burtt, Raymond S. Gervais, Joseph W. Wells

Syracuse Section

Donald Hermenet

Texas Section

Tom J. Sheffield

Texas Gulf Coast Section

James A. Embry

Twin City Section

Charles E. Grimes

Wichita Section

Norman W. Brandebery

Outside Section Territory

Douglas C. Ager, John H. Attenborrow, Daniel B. Geran, B. J. Green, Howard R. Johnson, D. E. Ricketts, M. S. Subramanian, Orest Yakimischak

Foreign

Keneth William Holmes Baldock, Australia; Alessandro E. Carelli, Italy; Ames Ishai, Israel; Donald Sainsbury Smith, England; George Philippe Russbach, France; Atsushi Watari, Japan

Whatever your operation—there's a dependable

BENDIX-WESTINGHOUSE COMPRESSOR for your job!

On city streets, over superhighways, along cross-country trails, everywhere motor transport is in use, you'll find Bendix-Westinghouse Tu-Flo compressors performing under the most rugged conditions . . . delivering an ample supply of air and maximum safety to trucks, trailers, buses and off-the-road vehicles.

Bendix-Westinghouse compressors are built to the most exacting standards and specifications. They've been laboratory-, road- and job-tested for billions of miles—efficiency-rated from the design board to final production tests—all with an eye to maintaining the highest quality ever built into a compressor.

Tu-Flo compressors feature lower discharge temperatures over the entire speed range, increased air delivery at low and intermediate speeds, improved oil control, efficient operation at higher maximum speeds to match trends in engine design.

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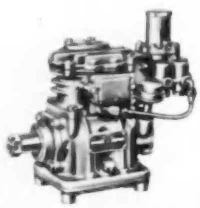
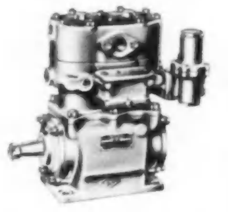
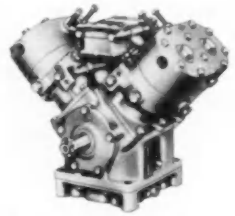


TU-FLO 300—Designed especially for lightweight trucks and school buses. Affords owners the comfort and safety of air brakes at low cost. Permits hauling air-equipped trailers.

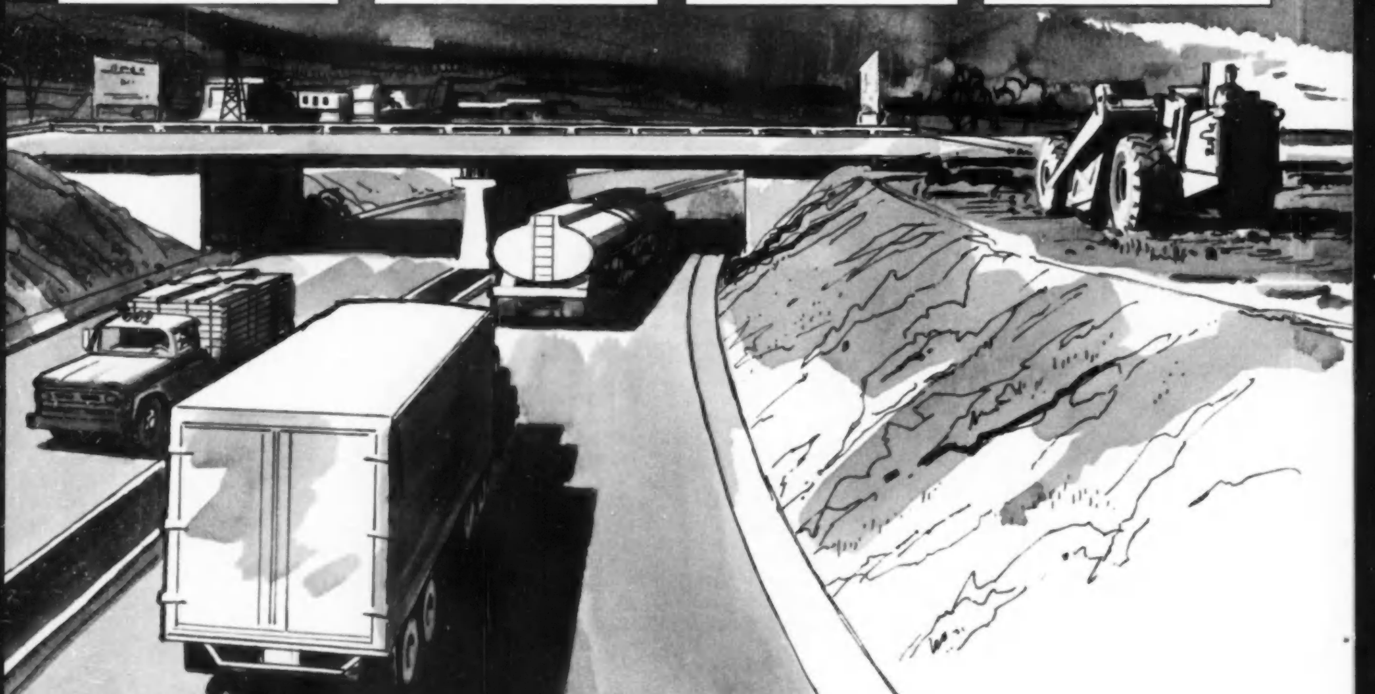
TU-FLO 400—This is the model that's most widely used by over-the-highway haulers. Available in either air- or water-cooled, self-lubricated or engine-lubricated types.

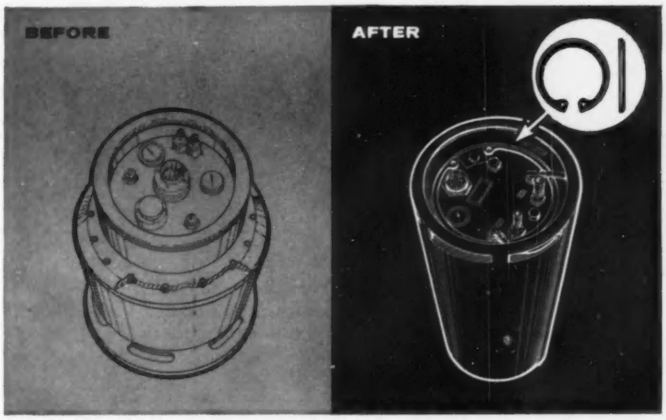


TU-FLO 500—For those operations where compressed air demand is heavy. Ideal for large city and interstate buses, off-the-road vehicles and other heavy-duty hauling operations.

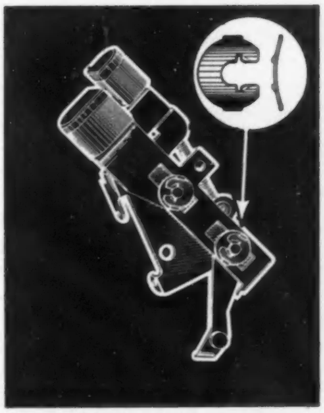


TU-FLO 1000—A new high capacity compressor designed for air supply systems, stationary or mobile. Available in self-lubricated or engine-lubricated, air- or water-cooled models.

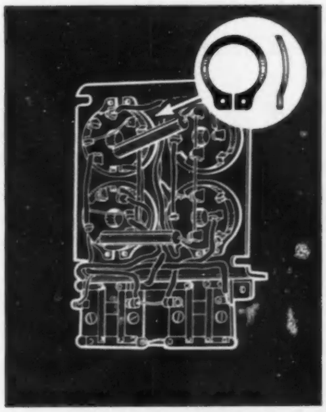




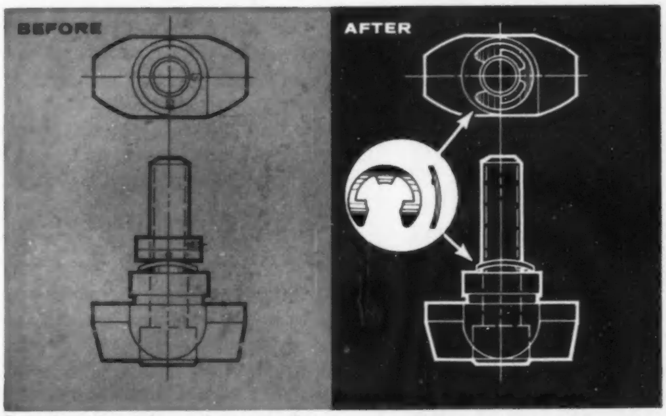
Pressure cover design simplified. Two axially assembled Truarc Series 5002 beveled rings eliminate 27 bolts, reduce machining and assembly time from 78 to 1½ hours and make possible drastic size and weight reductions. Rings retain two covers of a pressurized x-ray unit. **Savings: about $500 per unit.**



Parts eliminated in slide assembly. Two radially assembled Truarc Series 5139 Prong-Lock® Rings provide proper spring tension, eliminate looseness and wobble in this office calculator shift-slide. Original design called for a cut washer, spring washer, and cotter pin—all eliminated.



New way to install electron-tube sockets. Easy-to-apply Truarc Series 5101 bowed external rings lock tube sockets to chassis plate in this assembly. Bowed construction takes up tolerances of molded grooves, thickness of base. Individual sockets are removable for field service.



Quarter-turn clamp improved. A bowed washer and two locknuts were eliminated in this quarter-turn jig-and-fixture clamp by a Truarc Series 5131 bowed E-ring. The radially assembled ring holds the screw captive, provides required rotational drag between parts with sufficient tension to insure tight fit when the screw is first engaged. **Typical savings: $1.35/unit—assembly up 70%.**

Truarc rings for end-play take-up offer significant design advantages

A number of Truarc retaining rings are available to take up end-play or loose fit caused by accumulated tolerances and wear. The rings often eliminate spring washers, collars and set screws, nuts, bolts, rivets, cotter pins and other conventional fastening devices with outstanding cost savings in machining and assembly time.

Truarc retaining rings designed to deal with the end-play problem are of two general types: **bowed rings** for resilient end-play take-up and **beveled rings** for rigid end-play take-up.

Bowed retaining rings are widely used for pre-loading bearings, preventing vibration or oscillation in linkages, providing tension on adjusting screws. Of particular interest is the radially installed Truarc Prong-Lock® ring which locks securely to the shaft by means of two prongs. It provides exceptional thrust load capacity, may be used as a shoulder against rotating parts, and often eliminates springs, bowed washers and other tensioning devices.

In beveled rings for rigid end-play take-up, the groove-engaging edge is beveled at 15°. There is a corresponding bevel on the load-bearing groove wall. To take up end-play, the ring acts as a wedge between the outer groove wall and the part being retained.

These are just a few of the 50 functionally different types of Truarc retaining rings. They come in up to 97 standard sizes, six metal specifications, 13 different finishes. The entire line as well as accessory assembly tools, grooving tools, and over 70 typical applications are shown in the new catalog RR 10-58. Write for your copy today. And remember Waldes Truarc engineers are always ready to work with you on your specific projects. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y.

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PROPERTIES OF "DELRIN"

		INTERIOR HARDWARE (Door Handles, Window Cranks)	BUSHINGS & BEARINGS (Suspension Systems & Steering Linkages & Door Hinges)	SQUIRREL CAGE BLOWERS (for Heaters & Air Conditioners)	GEARS	MECHANICAL CABLE CASINGS (Push-Pull & Rotary)	INSTRUMENT HOUSINGS	WINDSHIELD WIPER (Pivots or Transmission Housings)	FUEL SYSTEMS (Pump and Carburetor Parts)	ELECTRICAL COMPONENTS (Bulb Sockets, Switch Housings & Toggles)
Tensile Strength	(ASTM D638): 10,000 psi at 73°F. 4,000 psi at 250°F.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stiffness	(ASTM D790): 410,000 psi at 73°F. 90,000 psi. at 250°F.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dimensional Stability: Load	0.5% Def. under 2,000 psi load at 122°F. (ASTM D621) 338° F. Heat Dist. Temp. at 66 psi (ASTM D648)		✓	✓	✓	✓	✓	✓	✓	✓
Dimensional Stability: Creep Resistance	0.4% Deformation at 113°F. and 10,000 hrs. under 500 psi load		✓	✓	✓		✓	✓	✓	✓
Dimensional Stability: Environmental	Linear Change +0.1% going from 0 to 50% RH +0.4% going from 0% RH to Saturation +0.1% in gasoline		✓		✓	✓	✓	✓	✓	✓
Solvent Resistance	Weight Change +0.3% in Gasoline at 73°F. +0.9% in Brake Fluid at 158°F. —0.2% in "Uniflo" at 158°F. +1.9% in Ethanol at 122°F. 0.0% in Kerosene at 140°F.		✓		✓	✓		✓	✓	✓
Toughness	Fatigue Endurance: 5,000 psi at 73°F. Impact (Izod— ASTM D256) 1.2 ft.lbs./in. at —40°F. 1.4 ft.lbs./in. at 250°F.	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bearing Properties	No Slip Stick No Squeak Coeff. of Friction on steel 0.2 ± 0.1 Dry 0.08 Lubricated	✓	✓			✓	✓	✓	✓	✓
Excellent Appearance	Colorability High Gloss Paintability	✓					✓		✓	✓
Serviceability	Wear Resistance Mar Resistance Stain Resistance Corrosion Resistance	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fabricability	Injection Molding Extrusion Machining	✓	✓	✓	✓	✓	✓	✓	✓	✓
Electrical Properties	(ASTM D150): Dielectric Constant: 3.7 Dissipation Factor: .004 at 73°F. from 10^2 to 10^5 cps						✓		✓	✓

POLYCHEMICALS DEPARTMENT

DU PONT

REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Department JJ-2, Room 2507D
Nemours Building, Wilmington 98, Delaware

I am interested in evaluating "Delrin" for the following use: ______

____

Name ______________________________

Company ______________ *Position* ______________

Street ______________________________

City ______________ *State* ______________


25
OOL
CAPACITY
48 SCHOOL CHILDREN
NO STANDEES

New BORG & BECK 2-Plate "Strap-Drive" Clutches

PACK MORE MUSCLE...WITHOUT ADDED SIZE

Trucks pay out on the road, not in the shop. So it's asking for trouble when a truck engine is too big for its clutch.

To help keep 'em rolling, Borg & Beck has developed a new line of 2-plate clutches with up to 40% greater load capacity . . . yet without any increase in nominal size.

Rated at 500 ft.-lbs. torque capacity, this new Borg & Beck Type 13E2 has 12⅞" O.D. x 7¼" I.D. facings . . . non-cushion rigid or flexible center drive plate . . . space for 16 heat treated coil springs of total load to suit type of service . . . "strap drive" for positive, trouble-free plate separation.

And like all Borg & Beck clutches, Type 13E2 is built to Borg & Beck's pace-setting standards for quality, performance and value. Consult our engineers for details.

BORG & BECK CLUTCH · THE STANDARD

Reg. U.S. Pat. Off.

BORG & BECK · B-W · BORG-WARNER ®

BORG & BECK®

THE AUTOMOTIVE STANDARD FOR MORE THAN 40 YEARS

BORG & BECK DIVISION, BORG-WARNER CORPORATION, CHICAGO 38, ILLINOIS

Export Sales: Borg-Warner International, 36 S. Wabash, Chicago 3

BORG & BECK DIVISION, BORG-WARNER CORPORATION, CHICAGO 38, ILLINOIS
Export Sales: Borg-Warner International, 36 S. Wabash, Chicago 3

When They Compare for
Clutch Torque Retention
...Fleet Operators Switch to LIPE!

Torque retention is an important matter to the steadily growing body of fleet owners who are changing over to Lipe. Their every-day experience tells them that Lipe Heavy-Duty Clutches mean *more* miles per gallon of fuel ... *more* ton-miles between shop-stops ... *more* capital-equipment-use per repair dollar. All because of Lipe's high retention of torque capacity. Why argue with these practical men? Give them what they want: Lipe Heavy-Duty Clutches, either as original or optional equipment. Let their growing numbers prove to you that *the trend is to* LIPE!

Lipe Heavy-Duty DPB Clutches are available in single and two-plate types; 12", 13", 14" and 15" sizes; with torque capacities from 300 to 1900 ft.-lbs.

Lipe-ROLLWAY CORPORATION
SYRACUSE 1, N. Y.

New steels are born at Armco

WHY THE ZINC COATING ON ARMCO ZINCGRIP STEEL **DOES NOT FLAKE OR PEEL**

On Armco ZINCGRIP® Steel, both the pure zinc and adherent iron-zinc alloy layer that make up the protective coating *adhere tightly* to the base metal. As a result, the coating does not flake or peel. It actually *stretches* to maintain protection when ZINCGRIP is formed or drawn.

SPECIAL COATING PROCESS

In Armco's patented coating process, top-quality cold-reduced steel strip passes through a furnace into a flux-free molten zinc bath. A special reducing atmosphere of nitrogen and hydrogen surrounds the steel from the time it enters the furnace. When strip dips into the bath, its surface is ideally prepared for union with the zinc. In addition, the steel has been heated and softened for greater workability.

For almost a quarter-century, many severely-fabricated products have been made from this special zinc-coated steel. Essentially, it offers advantages where corrosion of uncoated steels may cause poor appearance, malfunction, or loss of necessary strength. Headlight and taillight receptacles and interior body parts are typical examples.

For additional information about Armco ZINCGRIP STEEL, just fill in and mail the coupon.

ARMCO STEEL CORPORATION
1150 Curtis Street, Middletown, Ohio

Please send more information on Armco ZINCGRIP Steel.

Name____________________
Title____________________
Firm____________________
Street____________________
City__________ Zone_____ State________

ARMCO STEEL

ARMCO ®

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

Report from James Roberts, Chief Engineer, Galion Iron Works & Manufacturing Co., Galion, Ohio.

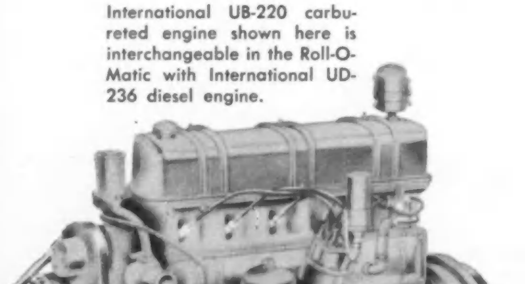
"We chose IH power for our pneumatic tire rollers because the wide speed range and favorable torque-speed curve of the International engines make it possible to have low-speed controlled operation for compacting, plus high-speed operation for traveling between jobs," says Mr. Roberts. "Other reasons we chose International were fast parts and service coverage, and operating economy."

GALION'S power choice for new Roll-O-Matic based on 30-year experience with INTERNATIONAL

After specifying IH engines in their road-building equipment for over 30 years, Galion engineers are more convinced than ever of the sale-clinching, profit-building advantages of International power. This long and satisfactory experience shows that 1) International's wide range of power sizes, with features for extreme adaptability in every size, presents a choice that will exactly match design specifications and power requirements. 2) International's world-wide network of parts and service facilities assures prompt attention to on-the-job problems—any time, any place. 3) Galion customers are assured of long-lasting, low-cost power in their road-building equipment. That's why Galion engineers specify IH engines for products like their new 9-wheel, 12-ton, self-propelled, Roll-O-Matic shown above. This new roller, like other Galion products, offers a choice of IH gasoline or diesel power.

When selecting the engine to power your products, check into the complete International engine line—14 carbureted models, 10 diesels, from 16.8 to 385 max. hp. You'll like the one common feature of all 24 engines: fastest payback power for users. Just call or write International Harvester Co., Engine Sales Department, Construction Equipment Division, Melrose Park, Ill.

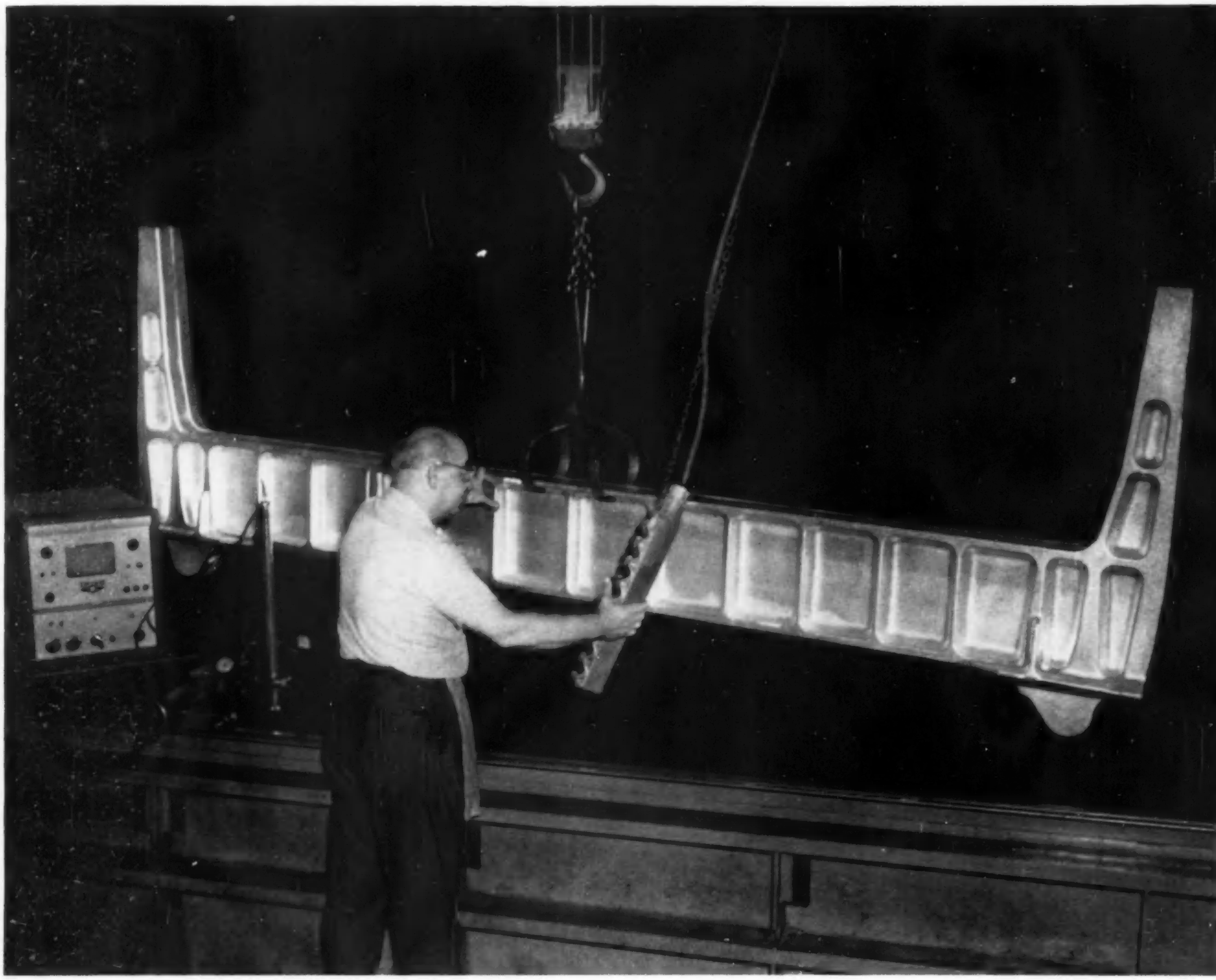
International UB-220 carbureted engine shown here is interchangeable in the Roll-O-Matic with International UD-236 diesel engine.



INTERNATIONAL® IH ENGINES

International Harvester Co., 180 N. Michigan Avenue, Chicago 1, Illinois

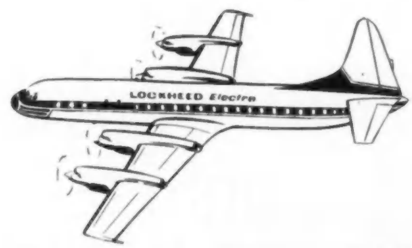
A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Self-Propelled Scrapers and Bottom-Dump Wagons . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines . . . Motor Trucks . . . Farm Tractors and Equipment.



Largest closed-die forging ever made for commercial aircraft

The forging of these 657 lb. bulkheads presented unusual problems—problems of die design, of forging, and of handling. The successful solution of these problems saved a costly assembly of many smaller parts—costly both in terms of dollars and pounds.

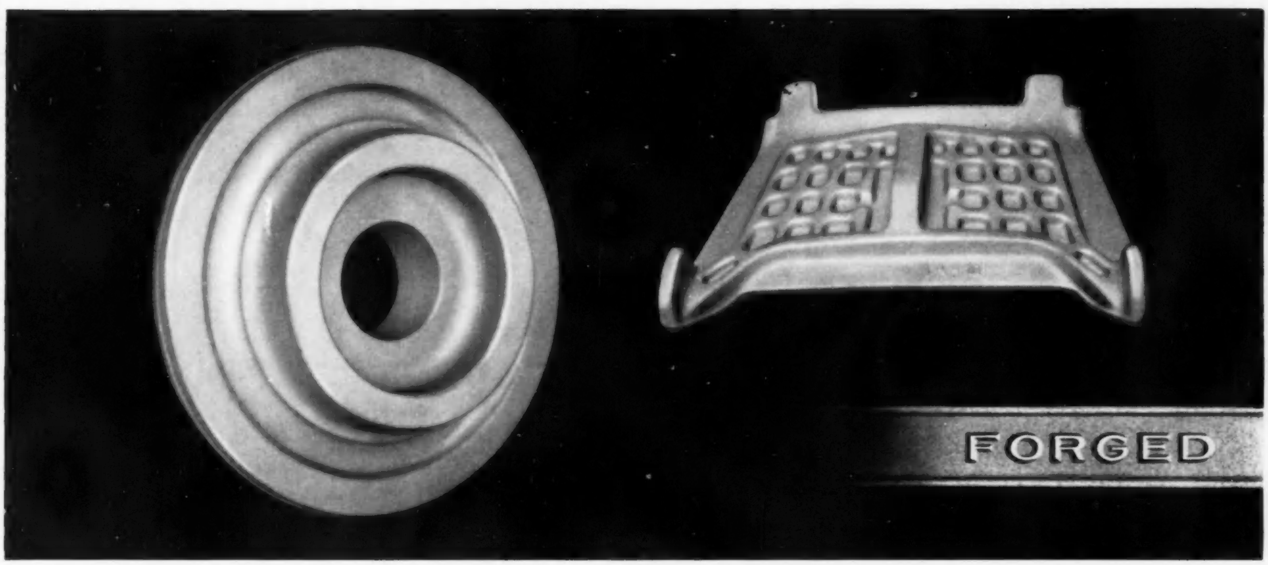
This is a typical Wyman-Gordon accomplishment—the result of over seventy-five years of forging experience, and today supported by the greatest range of heavy forging equipment and technical know-how in the industry.



Over 1000 Wyman-Gordon forgings pace advanced jet designs

In saluting the great achievement of America's commercial jet leadership, Wyman-Gordon takes great pride in having participated so extensively in the development of the aircraft industry from its very beginning.

In World War I, the use of forgings was confined to engine parts and Wyman-Gordon made most of them. Today, from the huge main bulkhead forging at the left to the engine parts below, Wyman-Gordon forgings are in the wings, fuselage, landing gear and engines of the four newest commercial jet aircraft. These and a great variety of other vital components are forged from many types of materials: aluminum, magnesium, titanium, steel, as well as many new uncommon alloys.



EST. 1883

In the highly stressed parts of modern aircraft, there is no substitute for forgings and in complicated forgings of difficult alloys, there is no substitute for Wyman-Gordon quality and experience. We are prepared to serve you at the design, engineering and purchasing stages of your developments.

WYMAN-GORDON

FORGINGS

of Aluminum Magnesium Steel Titanium . . . and Beryllium Molybdenum Columbium and other uncommon materials

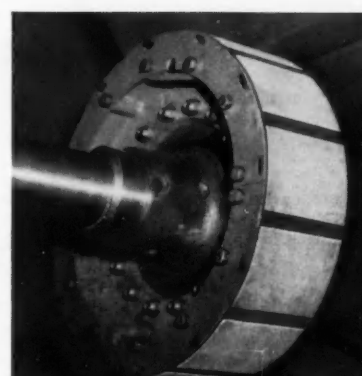
HARVEY ILLINOIS — WORCESTER MASSACHUSETTS — DETROIT MICHIGAN

GRAFTON MASSACHUSETTS — FRANKLIN PARK ILLINOIS — LOS ANGELES CALIFORNIA — FORT WORTH TEXAS

4-wheel tractor-scraper with Hi-Torque brakes

Heavy rear dump with Hi-Torque brakes

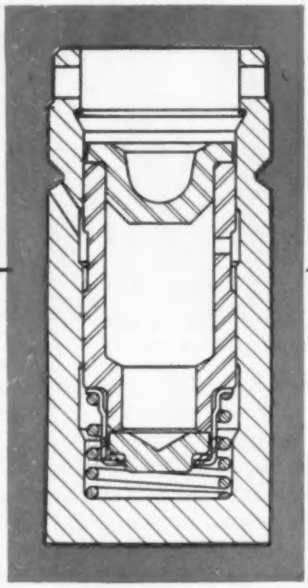
2-wheel tractor with Hi-Torque brakes



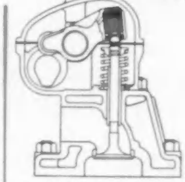
Full circle contact with drum is provided by Hi-Torque brakes giving maximum effective braking surface in the same size unit. Hi-Torque stops vehicles twice as fast as conventional brakes.

Designing valve gear?

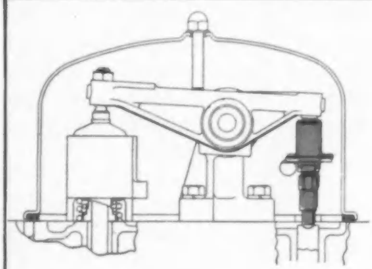
We invite you to use these specialized CHICAGO services



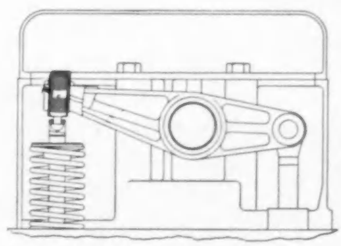
CHICAGO SPRING-LOADED FLAT VALVE HYDRAULIC TAPPET



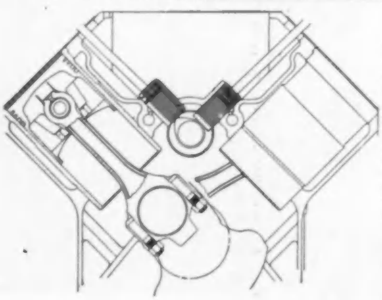
INSERT TYPE ROCKER ARM UNIT



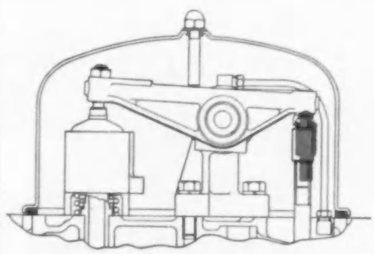
PUSH ROD TYPE FOR COMPRESSION RELEASE APPLICATION



THREADED TYPE ROCKER ARM UNIT



V-8 AUTOMOTIVE HYDRAULIC TAPPET APPLICATION



HYDRAULIC UNIT ON END OF PUSH ROD

Design

of complete valve gear installations for any type of engine . . . passenger car, truck, tractor, diesel, aircraft or industrial.

Development engineering

based on years of specialized experience in valve gear problems. The skills of our engineers will prove a valuable addition to your own engineering staff.

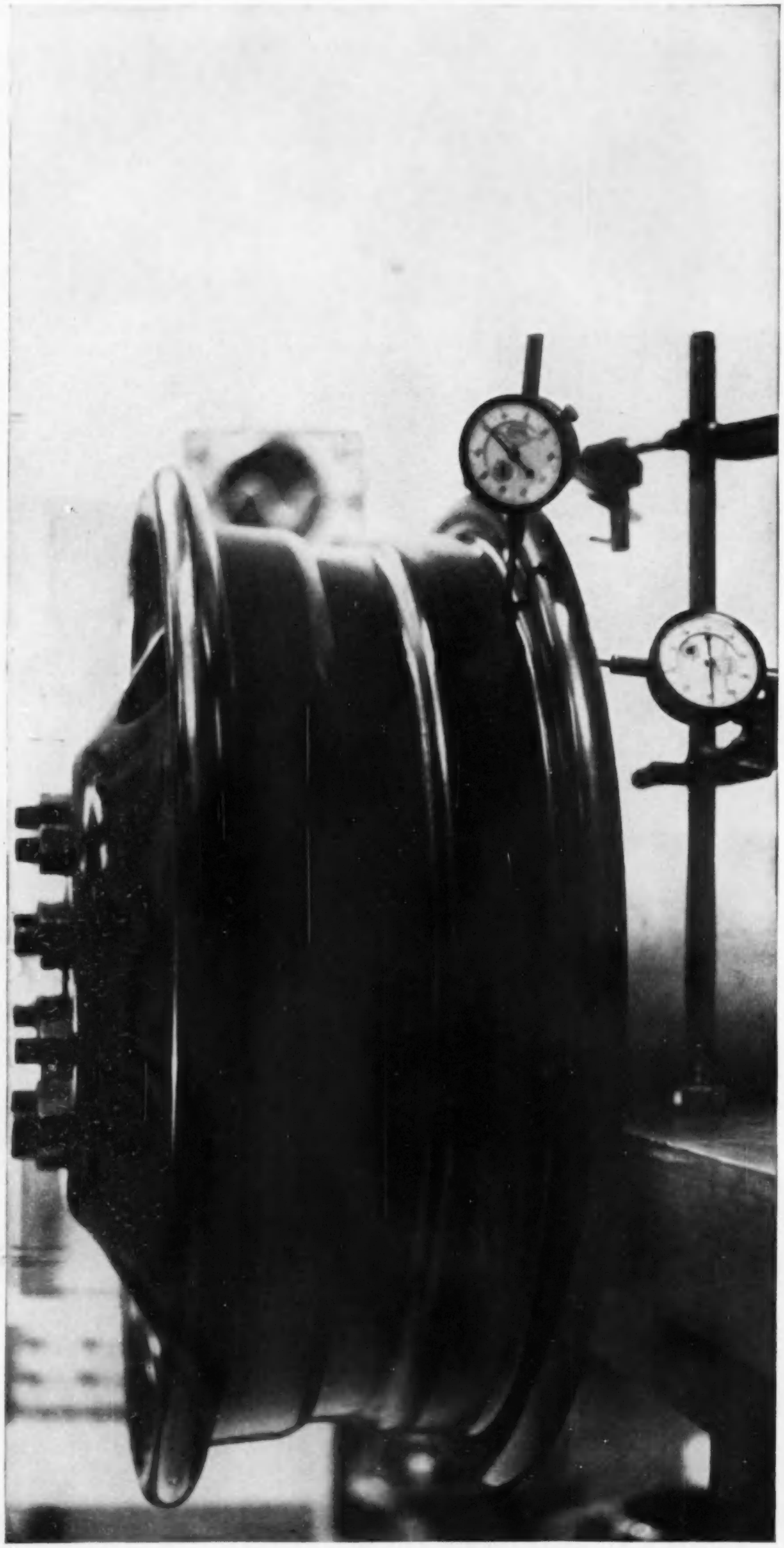
Tappet manufacturing

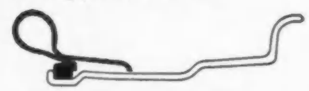
CHICAGO's facilities insure precision-manufacturing, scientific testing and rugged, trouble-free performance in every tappet. We will welcome the opportunity to serve you.

THE CHICAGO SCREW COMPANY

ESTABLISHED 1872 • DIVISION OF STANDARD SCREW COMPANY

2701 WASHINGTON BOULEVARD, BELLWOOD, ILLINOIS





NEW GIANT AT WORK on Double Diamond Gears

This huge, continuous, carburizing, hardening and draw furnace now permits even greater instrument control in heat treating DOUBLE DIAMONDS for maximum wear resistance and load-carrying capacity. So far as we can discover no more efficient furnace could be installed to achieve the quality characteristics our gear customers have come to expect.

At your request, our gear engineers would be pleased to describe this process in greater detail and to explain, as well, what our recently expanded facilities can mean in terms of this pledge: "DOUBLE DIAMOND Gears offer the advantages of lower installed cost and economical and dependable service on the job . . . gears that do credit to your product and reputation."

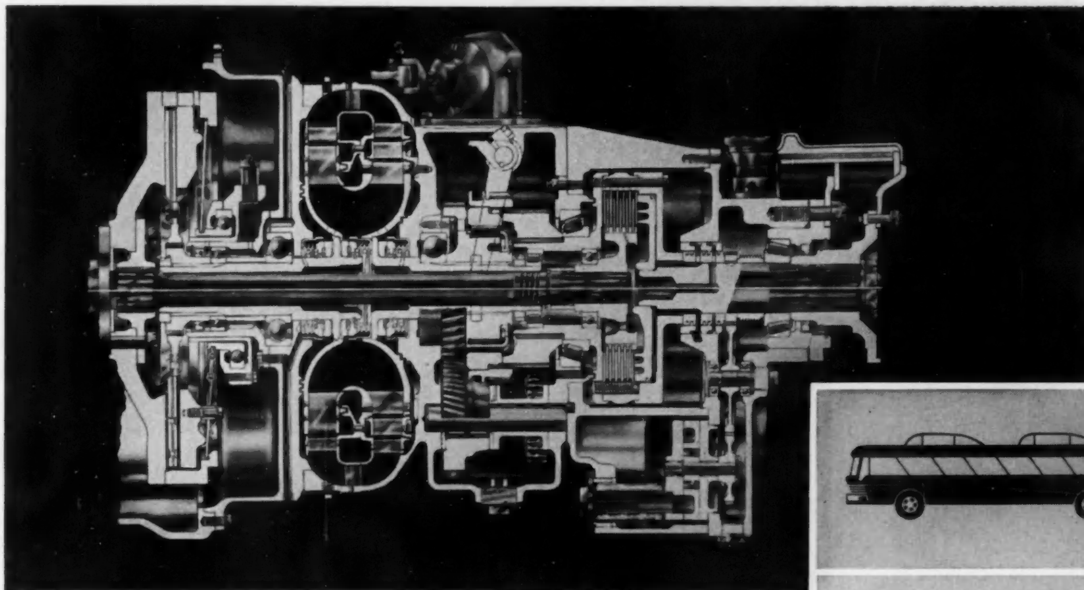
EATON

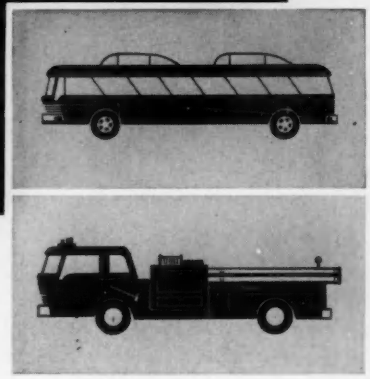
AUTOMOTIVE GEAR DIVISION
MANUFACTURING COMPANY
RICHMOND, INDIANA

EATON®

GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS

DOUBLE DIAMOND GEARS ®





Spicer 183 Turbo-Matic...

The Transmission That Thinks for Itself!

Just turn the ignition key and accelerate . . . the 183 Turbo-Matic does the rest. Acceleration is smooth and rapid from standstill to direct drive, regardless of load condition or driver skill. The mental and physical fatigue of professional driving is materially reduced. Drivers are fresher, more alert, all day.

In buses and emergency vehicles Turbo-Matic multiplies available engine torque by as much as 5.6 times to provide unexcelled power utilization for improved operating efficiency and minimum maintenance downtime.

Many American cities have discovered the operational advantages of the heavy-duty Spicer 183 Turbo-Matic transmission. Ask the Dana engineers to help you adapt it to your vehicles.

• • •

Write for your free copy of booklet No. 806, which describes the outstanding features of the Turbo-Matic transmission.

DANA Spicer

DANA CORPORATION

Toledo 1, Ohio

Serving Transportation—Transmissions • Auxiliaries • Universal Joints • Clutches • Propeller Shafts • Power Take-Offs • Torque Converters • Axles • Powr-Lok Differentials • Gear Boxes • Forgings • Stampings • Frames • Railway Drives

Many of these products are manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario

U. S. PAT. NO. 2,789,872 STAINLESS STEEL OIL RING

Sealed Power has walked (and sometimes run) along the pathways of progress with the reciprocating engine industry for virtually 50 years.

Through one significant era of development after another our engineers, our metallurgists, and production specialists worked with engine designers.

We measure our progress in terms of our contributions to the advancing efficiency of the internal combustion engine . . . to refinements in piston ring design . . . to the high performance standards so rapidly attained in sealing and transmission rings.

Your future is our future. We look to it in this way.

Our research programs, the talents of our engineers, the forward steps in manufacturing—all these are presently, and will continue to be, dedicated to our common cause.

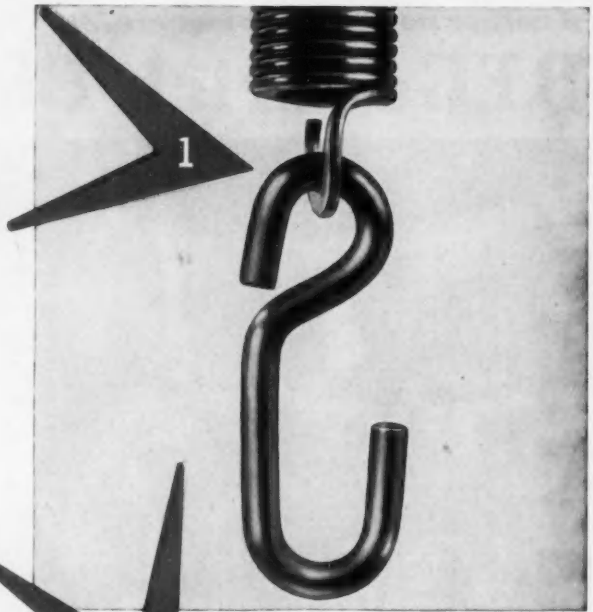
Sealed Power

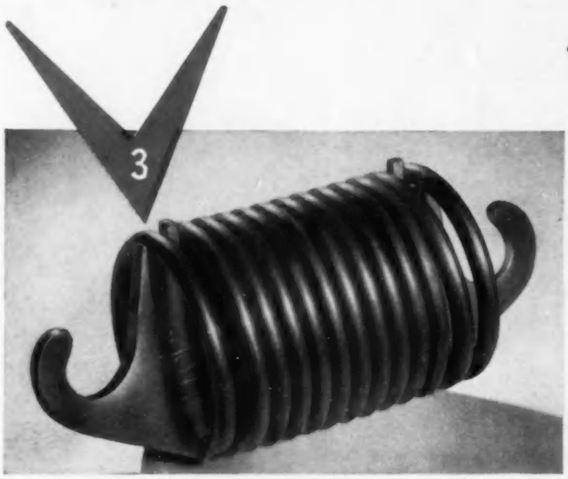
Preferred Performance

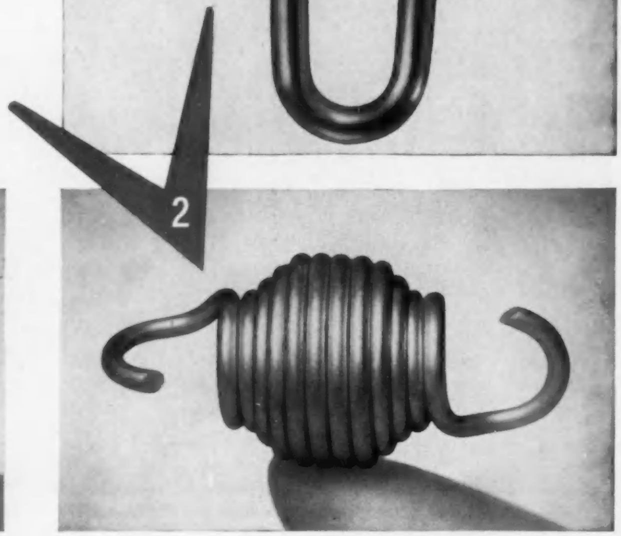
SEALED POWER CORPORATION, MUSKEGON, MICHIGAN • ST. JOHNS, MICHIGAN • ROCHESTER, INDIANA • STRATFORD, ONTARIO • DETROIT OFFICE • 7-236 GENERAL MOTORS BUILDING • PHONE TRINITY 1-3440

PISTONS • PISTON RINGS • SLEEVES • SLEEVE ASSEMBLIES • SEALING RINGS FOR ALL APPLICATIONS

Why it pays to look at the end in the beginning







1. In this pick-arm spring for a textile machine, natural frequency vibration plus rigid end restraint caused early failure. By redesigning spring and adding swivel hook to end assembly, failure was avoided and cost reduced as well.

2. Fatigue failure caused by bending stresses occurs where end hooks join working coils. In this method of reducing the combined stress, two coils at each end are wound with a reduced diameter.

3. Another method for reducing stress concentration where end hooks join coils is to thread a flat stamping into end coils.

Here are a few examples of why it pays to call on the springmaker early in your design problems. End-hook failure of extension springs is a common occurrence that experience can help avoid. Check your specifications for performance and production economy by consulting an A.S.C. spring engineer. Write for bulletin "How to Solve Your Spring Design Problems."

5903

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
Raymond Manufacturing Division, Corry, Penna.
Ohio Division, Dayton, Ohio
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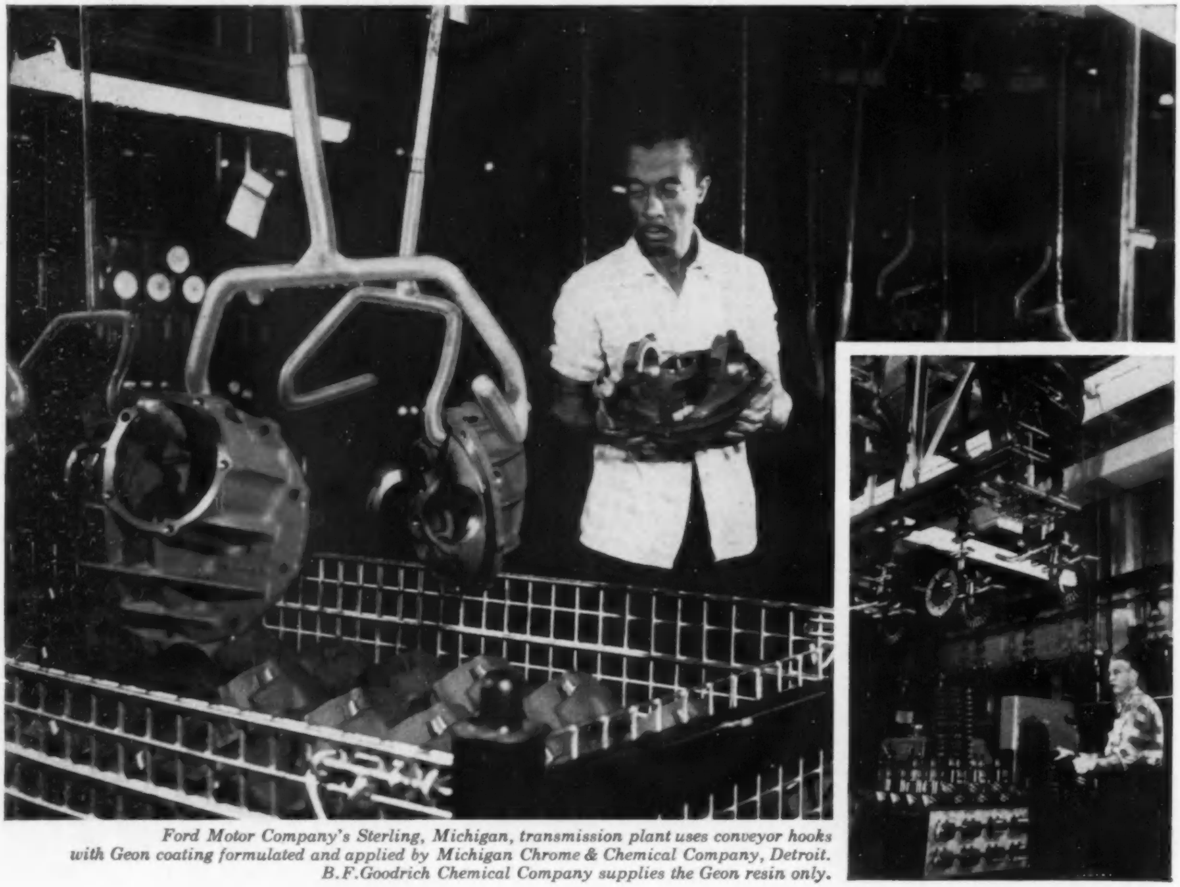
Seaboard Pacific Division, Gardena, Calif.
Cleveland Sales Office, Cleveland, Ohio
Dunbar Brothers Division, Bristol, Conn.
Wallace Barnes Steel Division, Bristol, Conn.

Canadian Subsidiary: Wallace Barnes Co., Ltd., Hamilton, Ont. and Montreal, Que. Puerto Rican Subsidiary: Associated Spring of Puerto Rico, Inc., Carolina, P.R.

Another new development using

B.F.Goodrich Chemical *raw materials*



Ford Motor Company's Sterling, Michigan, transmission plant uses conveyor hooks with Geon coating formulated and applied by Michigan Chrome & Chemical Company, Detroit. B.F.Goodrich Chemical Company supplies the Geon resin only.

"Soft touch" of Geon safeguards parts quality

The overhead conveyor system in this automatic transmission plant uses 26,000 hooks coated with Geon polyvinyl material. The soft yet durable coating made from Geon protects finished parts while they are carried from machining to assembly stations.

In addition to giving the hooks a long and profitable service life, the Geon coatings come in any color, permitting color-coding for multiple conveyor operations.

Versatile Geon is ideal for many coating applications, since it disperses readily in the coating formula. Geon can be used to coat paper, textiles, metals or almost any material to provide new or improved advantages. Hundreds of types of Geon resins, plastics, latices and polyblends are available, tailored to specific uses for coatings, moldings, extrusions, or rigid or foam applications. For information, write Dept. GU-1. B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

A TRADE MARK OF B.F.GOODRICH CHEMICAL COMPANY

Geon

VINYLS

A DIVISION OF THE B.F.GOODRICH COMPANY

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

B.F.Goodrich

GEON vinyls • HYCAR rubber and latex • GOOD-RITE chemicals and plasticizers

KRALASTIC® FOR CARS

DURABLE • LIGHTWEIGHT • VERSATILE • ECONOMICAL

One of the toughest, strongest and most thoroughly proven of the many new plastics materials, KRALASTIC offers the automotive industry a unique combination of manufacturing and selling advantages. Essentially blends of thermoplastic resins and nitrile rubber, these molding and extrusion compounds have demonstrated their superiority over other materials in products from hearing-aid cases to football helmets. Extruded as pipe, KRALASTIC has proved so phenomenally successful that nearly 10,000 miles of it are in use for water, gas, chemical and electrical lines.

KRALASTIC MM, recently introduced, offers such a combination of toughness and resistance to heat, staining and abrasion that it actually *rivals nylon at a fraction of the cost.*

Investigate KRALASTIC. Consult us for experienced application advice or for whatever assistance you may require.

Typical KRALASTIC parts include instrument panel, window frames, garnish moldings, shrouds, switches, impellers and door handles.

PROPERTY	UNITS	ASTM TEST METHOD	KRALASTIC B	KRALASTIC F
PHYSICAL				
Specific Gravity (Natural Color)*			1.06	1.04
Impact Strength (¼" Bar Sample)				
Izod Notched, 73°F.	ft. lbs./in. notch	D256-56	5-9	3-6
Izod Notched, 32°F.	"	"	1.8	1.5
Izod Notched, −40°F.	"	"	0.6	0.4
Charpy Unnotched, 73°F.	ft. lb./in.	"	35-58	28-42
Charpy Unnotched, 32°F.	"	"	35-50	40-45
Charpy Unnotched, 0°F.	"	"	35-50	21-26
Charpy Unnotched, −40°F.	"	"	8	6-8
Compressive Strength	psi	D695-54	6,400	5,800
Compressive Modulus	psi	D695-54	290,000	280,000
Flexural Strength	psi	D790-49T	8,000	7,500
Flexural Modulus	psi	D790-49T	260,000	250,000
Tensile Strength	psi	D638-52T	5,500	5,000
Hardness, Rockwell	R Scale	D785-51	96	92
Thermal Coefficient of Expansion	in./in./°F.	D696-44	0.000056	0.000056
Thermal Conductivity	B.T.U./hr./ft.^{2} per°F./in.	C177-45	1.7	2.0
	Cal/sec./cm^2/°C./cm		0.00060	0.00069
Specific Heat	B.T.U./lb./°F.		.37	.36
Deflection Temperature, 264 psi	°F.	D648-45T	187	185
Water Absorption, 24 hrs.	% Gained	D570-54T	0.3	0.2
Compression Ratio (Bulk Factor)		D392-38	1.8-2.0	1.8-2.0
Compression Molding				
Temperature	°F.		325-400	325-400
Pressure	psi		1000+	1000+
Injection Molding				
Temperature	°F.		375-600	350-600
Pressure	psi		6,000-30,000	6,000-30,000
Mold Shrinkage (Average)	in./in.		.004-.005	.004-.005
Extruding Temperature	°F.		350-450	350-450
Calendering Temperature	°F.		350-400	325-400
ELECTRICAL				
Dielectric Strength Short Time ⅛"	Volts/Mil	D149-55T	312	351
Volume Resistivity (35% Relative Humidity at 73°F.)	Ohm/Cm.	D257-54T	1.8×10^{13}	1.1×10^{13}
Dielectric Constant		D150-54T		
60 CPS		"	4.76	4.15
1000 CPS		"	4.45	4.20
10^6 CPS		"	3.78	3.61
3000×10^6 CPS		"	2.76	2.70
Dissipation Factor		D150-54T		
60 CPS		"	0.021	0.015
1000 CPS		"	0.002	0.002
10^6 CPS		"	0.026	0.026
3000×10^6 CPS		"	0.006	0.006
Loss Factor		D150-54T		
60 CPS		"	0.101	0.062
1000 CPS		"	0.010	0.007
10^6 CPS		"	0.099	0.094
3000×10^6 CPS		"	0.016	0.015

*Specific gravity of colors will vary with the pigmentation used.
†Heat distortion of 225°F. is obtained by annealing for 2 hours at 220°F.

These KRALASTIC materials are arranged in order of decreasing Impact Strength except J, L and HTHT, which have special outstanding properties.

Distinctive Properties:

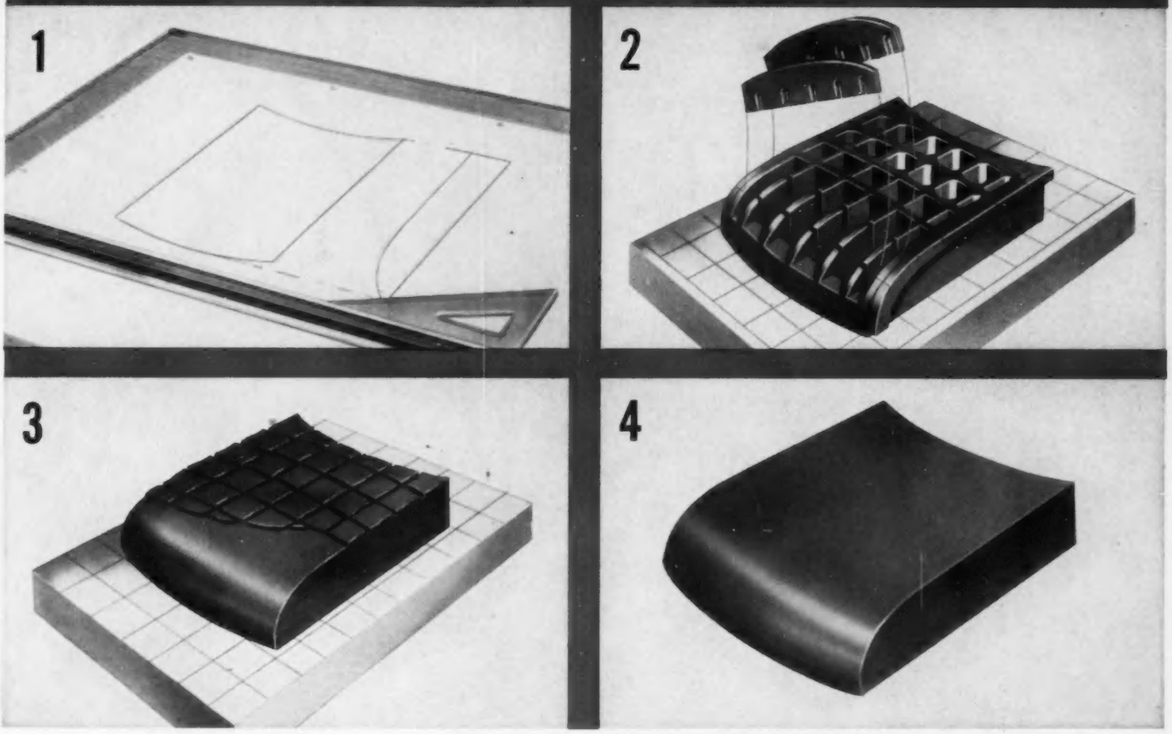
- High impact resistance
- Extreme toughness combined with hardness
- Lightweight: ½ weight of aluminum; ⅐ weight of iron
- Noncorrosive, nonelectrolytic
- Readily sawed, drilled and threaded
- Quickly solvent welded
- Dimensionally stable over a wide temperature range
- Opaque built-in colors

Major Uses:

- Automotive components
- Pipe and pipe fittings
- Light wheels, gears and pulleys
- Machine housings and parts
- Textile warp tubes and bobbins
- Radio and camera cases
- Football and safety helmets
- Tote boxes
- Hose nozzles and fertilizer injectors

KRALASTIC 2907	KRALASTIC MM (Formerly Kralastic 2590)	KRALASTIC D	KRALASTIC J	KRALASTIC L	KRALASTIC HTHT
1.06	1.07	1.05	1.02	1.02	1.08
1.5-3.5	0.7-1.5	0.4-1.3	6-9	5-7	3-4
1.8	0.7	0.4	5-6	3-5	2.0-2.5
0.3-0.8	0.4	0.4	1-3	1.5-2.5	0.3-0.5
30-50	20-30	23-33	25-35	30-45	30-50
—	—	23-33	25-30	—	20-30
—	—	10	—	30-40	15-25
25	20	8	35-40	30-40	10-15
10,500	11,000	9,000	4,000	5,600	10,000
350,000	370,000	430,000	190,000	200,00	290,000
11,500	13,500	11,500	4,000	6,500	12,000
400,000	450,000	390,000	170,000	275,000	370,000
7,800	8,800	6,500	3,000	4,000	8,000
115	118	108	62	88	116
0.000042	0.000032	0.000047	0.000073	0.000048	0.000038
1.6	1.8	1.7	2.1	2.3	2.5
0.00057	0.00062	0.00058	0.00072	0.00079	0.00086
.37	.38	.37	.38	.40	.37
198	200	193	172	175	225†
0.3	0.3	0.2	0.2	0.2	0.2
1.8-2.0	1.8-2.0	1.8-2.0	1.8-2.0	1.8-2.0	1.8-2.0
325-400	325-400	325-400	325-400	325-400	350-500
1000 +	1000 +	1000 +	1000 +	1000 +	1000 +
375-600	350-600	350-600	350-600	350-600	400-600
6,000-30,000	6,000-30,000	6,000-30,000	6,000-30,000	6,000-30,000	6,000-30,000
.004-.005	.004-.005	.004-.005	.004-.005	.003-.004	.004-.008
350-400	350-450	350-450	350-450	350-450	400-500
—	—	325-400	300-375	300-375	—
385	386	350	340	384	363
$>2.7 \times 10^{16}$	$>2.7 \times 10^{16}$	$>10 \times 10^{13}$	0.54×10^{13}	1.3×10^{13}	$>10 \times 10^{13}$
3.17	3.10	3.41	4.00	3.70	3.54
3.12	3.08	3.54	4.47	3.52	3.43
3.08	3.02	3.20	4.05	3.48	3.24
—	—	2.66	2.80	—	—
0.005	0.004	0.009	0.011	0.073	0.034
0.005	0.005	0.002	0.002	0.008	0.012
0.009	0.010	0.017	0.018	0.020	0.021
—	—	0.003	0.008	—	—
0.016	0.012	0.030	0.043	0.270	0.120
0.016	0.015	0.005	0.010	0.028	0.040
0.028	0.030	0.053	0.072	0.069	0.067
—	—	0.009	0.021	—	—

NOW! A FAST, ECONOMICAL METHOD FOR MAKING MASTER MODELS



...developed by Kish Industries using

RCI EPOXY RESINS

• Master models are made faster and better using this new Kish process* made possible by a completely different type of epoxy formulation – based on RCI EPOTUF epoxy resins.

Here, briefly, is how the Kish system works:

(1) Starting with the draft or styling print, templates are cut from pre-cast KiPlaBoard (fully-cured epoxy board made in varying thicknesses).

(2) These templates are bonded into an "egg crate" having the general shape of the model.

(3) The open areas of the "egg crate" are filled with Kish No. 44 Resin Compound (formulated with RCI EPOTUFS) and after the compound cures the rough model is shaped and finish-surfaced using standard woodworking techniques.

(4) The finished model is grain-free, dimensionally stable, and unaffected by moisture and weather. It will not chip or deteriorate with age and can be altered simply by bonding additional Epotuf-based material on the model.

This remarkable Kish innovation is just one of a constantly growing number of jobs done more efficiently and economically with versatile RCI EPOTUF epoxy resins.

**Complete information on the Kish System is available from Kish Industries, Inc., 1301 Turner Street, Lansing 6, Michigan.*

Creative Chemistry ...Your Partner in Progress

REICHHOLD

REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N. Y.

Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenol • Hydrochloric Acid • Formaldehyde • Phthalic Anhydride • Maleic Anhydride
Ortho-Phenylphenol • Sodium Sulfite • Pentaerythritol • Pentachlorophenol • Sodium Pentachlorophenate • Sulfuric Acid • Methanol

There's almost no limit to the things Bundy can mass-fabricate

Bundyweld is the only tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅝" O.D.

Maybe your tubing problems don't run to animal shapes, but it's likely that you can benefit from Bundy's experience in mass-fabricating complex tubing parts. Here's why:

Precision bending: Bundy-developed machines turn out parts to exacting customer specifications . . . *with mass-fabrication savings.*

Great strength: Your component will be fabricated from Bundyweld®, the copper-brazed steel tubing that's *double-walled* from a single steel strip. Bundyweld, the tubing standard of the automotive industry, is used in over 95% of today's cars.

Expert design service: You can call on our engineering staff at any time to help with the design of your product. We may be able to point out short cuts that save you money without compromising engineering standards. Covered by Government Spec. MIL-T-3520, Type III.

Next time you have a tubing problem, better call Bundy *first.* Phone, write, or call Bundy Tubing Company, Detroit 14, Michigan.

in this zone, stainless steels that remain ductile with high strength and stability

In the search for favorable strength-to-weight ratio, high temperature alloys have been developed with extreme strength up to 1000 F, but at the expense of ductility.

In AM 350 and AM 355, Allegheny Ludlum's precipitation hardening stainless steels, you have high hardness and stability from room temperature to 1000 F, plus almost twice the ductility!

These advantages are followed by easy formability using normal techniques. AM 350 and AM 355 can be brazed and welded as easily as the common stainless steels. They can be spun, formed and machined without special preparation.

AM 350 is available commercially in sheet, strip, foil, small bars and wire. AM 355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars, wire, sheet and strip.

For further information, see your A-L sales engineer or write for the new technical booklet, "AM 350 and AM 355." **Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Penna.**

ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

One in a series of technical reports by Bower

BEARING BRIEFINGS

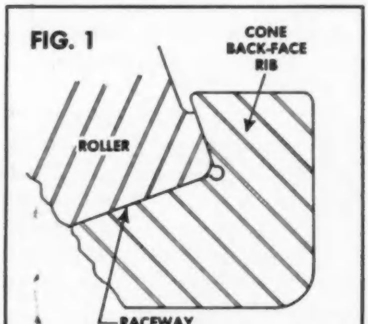
BEARING GEOMETRY MAKES OR BREAKS BEARING PERFORMANCE

To develop high capacity and optimum performance in a tapered roller bearing, it is essential that roller alignment be accurate. Correct roller alignment, in turn, depends on a critical geometric relationship between the cone back-face rib, and the cone raceway.

Perfection in this geometric relationship compels the rollers to align themselves perfectly with respect to the bearing geometry, and each roller shares equally in the work that is imposed. Figure 1 diagrams the important elements involved.

When this rib-to-raceway relationship is incorrect (because of either faulty bearing design or manufacturing inaccuracies), rollers experience misalignment and begin to skid and skew under load. As engineers know, poor performance and premature bearing failure are inevitable under these conditions.

FIG. 1



In the design and manufacture of Bower tapered roller bearings, Bower engineers take great care to generate and hold an exact face angle on the cone back-face rib. In practice, this means that Bower bearings are designed for maximum life and optimum performance under any operating conditions. It means that Bower bearings retain accurate roller alignment under all speeds and loads up to the maximum for which the bearing is rated.

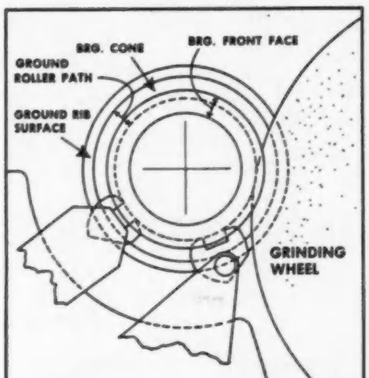
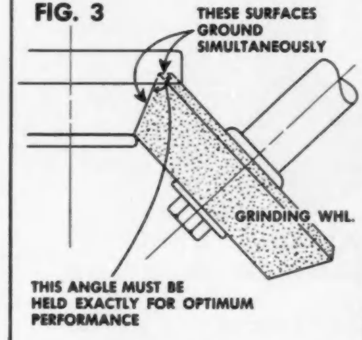


FIG. 2
FRONT VIEW

It's one thing to develop proper bearing design on paper, but quite another to carry it out consistently in manufacture. To this end, Bower engineers were instrumental in the design and development of a unique centerless grinder on which Bower precision grinds each bearing's cone raceway and rib-face simultaneously. The results obtained from these machines invariably meet or surpass Bower's exacting requirements and assure perfect roller alignment.

Figures 2 and 3 are front and top views which illustrate Bower's technique of centerless grinding rib-faces and cone raceways together. As a result, every component in a Bower bearing is perfectly concentric about its rolling axis.

FIG. 3

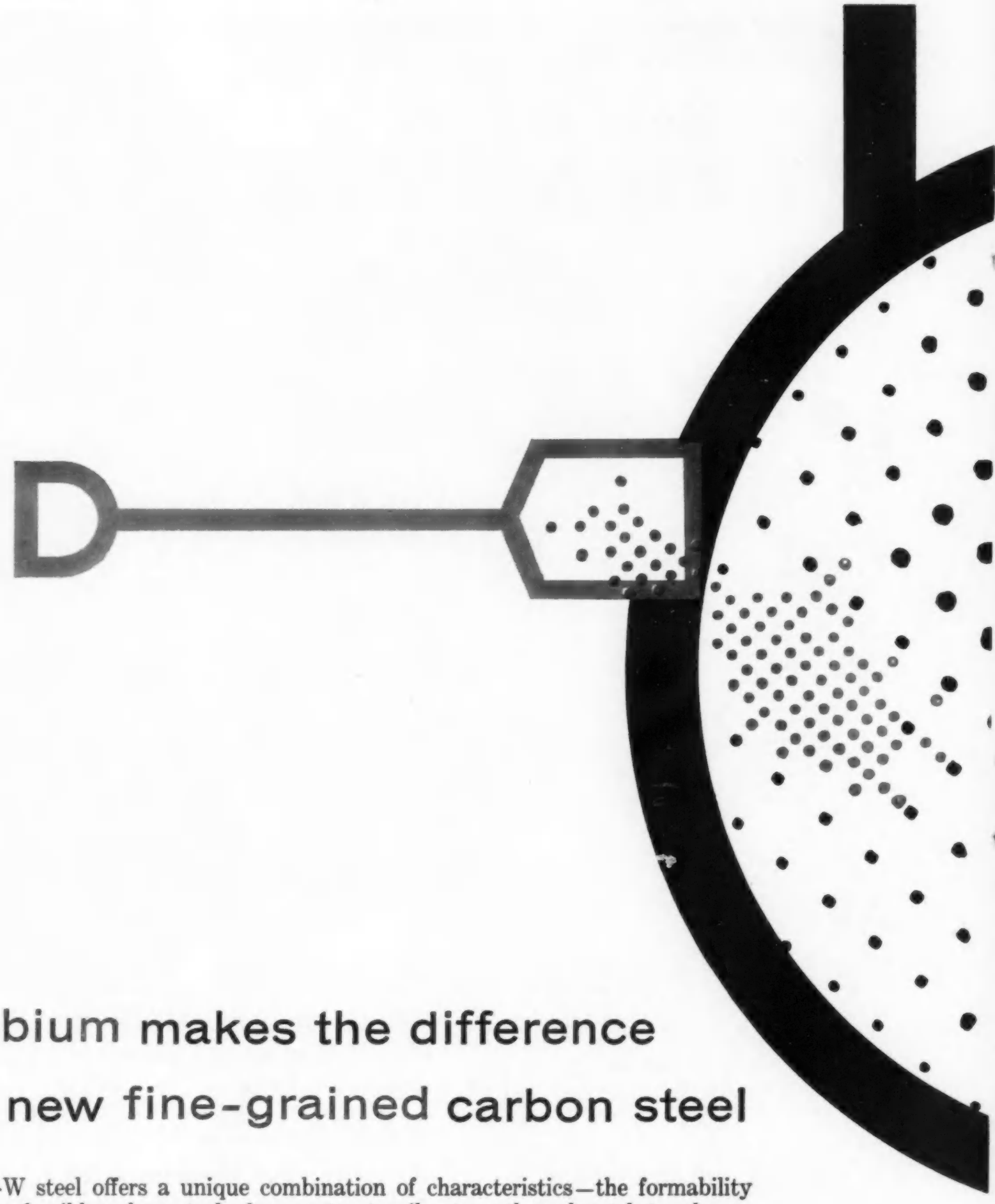


★ ★ ★ ★

When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN



Special Ray-BOND Adhesive

BONDS GLASS TO PLASTIC

To reduce breakage and assembly time of glass vacuum bottle fillers, The American Thermos Products Company, Norwich, Connecticut, undertook to replace an aluminum cap with a polyethylene protector for the evacuation tip of the glass filler.

The problem was bonding the traction-free polyethylene to the smooth glass surface. Existing adhesives couldn't do the job. R/M adhesive specialists, working closely with Thermos Company engineers, quickly developed a special adhesive.

The result is a superior bonding agent, R/M's new R-84002, for "Mylar," polyethylene, glass and other slick-surface, bond-resistant materials. Based on a thermoplastic synthetic resin, R-84002 has temperature tolerances ranging from −20 to +200°F.

Regardless of your application Ray-BOND adhesives of new or existing formulations can be tailored to your special bonding, laminating, sealing or coating requirement. Your costs are reduced; your production is improved. Let us prove this to your satisfaction. Call on Raybestos-Manhattan engineers today without obligation.

R/M Bulletin No. 700 contains helpful engineering information on Ray-BOND adhesives, protective coatings and sealers, and casting, encapsulating and potting compounds. Write for your free copy.

RAYBESTOS-MANHATTAN, INC.

ADHESIVES DEPARTMENT, Bridgeport, Conn. • Chicago 31 • Detroit 2 • Cleveland 16 • Los Angeles 58

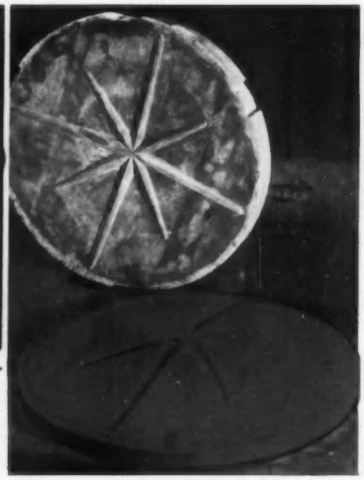
RM

SILICONE NEWS from Dow Corning

Easier Way to Make Prototypes

↑ STEP 1

STEP 2 →



STEP 3

Case History: Making Hub-cap Embossing Dies

SILASTIC RTV SILICONE RUBBER Molds Strip Fast and Easy

Silastic® RTV, the Dow Corning liquid silicone rubber that vulcanizes at room temperature, provides a new and better way to make prototype parts. This fluid rubber is easily poured into, over, or around complex shapes, and sets up in a short time. The result is a strikingly accurate mold, into which you can pour many casting materials such as plaster, waxes or plastics. Because Silastic RTV will withstand temperatures up to 500 F, many molten metal alloys can also be cast. Silastic RTV strips readily from most materials without loss of pattern detail. Here's how one automotive industry supplier — Cadillac Stamp Co. — uses Silastic RTV to make templates for hubcap embossing dies.

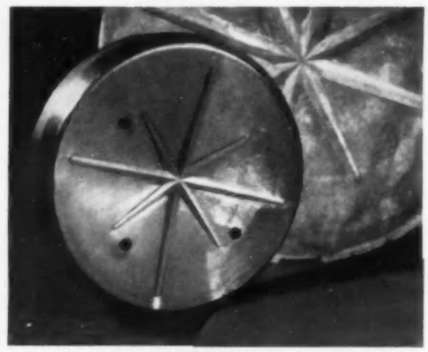
Step 1. A wood pattern was machined to the exact configuration of the hubcap design. The intricate design requires a material that releases easily without loss of detail. Silastic RTV has been poured on the pattern to make a "negative" mold.

Step 2. The Silastic RTV mold is then used to cast a plastic. A "positive" image that faithfully reproduces the original pattern results. This image forms a template or prototype from which a pantograph-type engraving machine can sink dies.

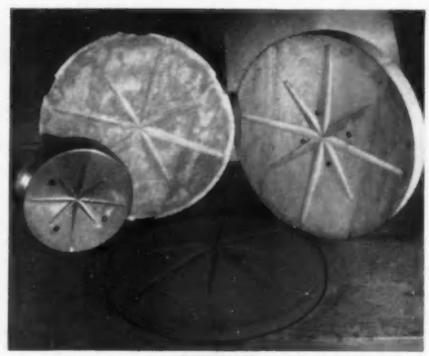
Step 3. Now we return to the rubber mold, and this time more Silastic RTV has been poured into it. A rubber "positive" results. The two rubber molds release readily and two exactly matching parts result.

Step 4. From the rubber "positive", another plastic image is cast. Silastic RTV strips off easily . . . a crucial factor. The second plastic template is now ready for the engraving machine to sink dies. Size is reduced by one-half in the process. Note size of finished hubcap.

Step 5. Here are all the steps reassembled. Remember — both embossing dies were made from one wood original, thanks to Silastic RTV. Throughout the process there has been no loss of pattern detail . . . and exactly matched dies have been made.



STEP 4



STEP 5

Is there a way that this easy handling and faithful reproduction can help you? We'll be glad to assist in adapting Silastic RTV to your operations.

Free Sample. Write on your letterhead for data and sample of Silastic RTV. Address Dept. 9102

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

METRO-MITE, today's economical small delivery truck. Components of USS COR-TEN High-Strength Low-Alloy Steel contribute to its lightness, strength, and economy of operation.

It's tough . . . it's light . . . it's the Metro-Mite

Built strong and light with components of High-Strength Steel

Looking for a delivery truck that can economically handle payloads up to 1000 pounds? One with a capacity of about 200 cubic feet? Or are you a stickler on low gas consumption? Well, here's news about a new delivery truck that combines *all* these advantages . . . International Harvester's METRO-MITE, engineered and built by their subsidiary, Metropolitan Body Company, Bridgeport, Connecticut.

One of the reasons the Metro-Mite is so popular is unitized body construction, with flooring, step wells, wheel housings and body shell supports made of High-Strength Steel. These sections, using 12- to 16-gage sheets, are welded together into a strong, firmly aligned, unitized structure. To it are bolted all chassis and body subassemblies.

USS COR-TEN Steel is a remarkable high-strength low-alloy brand of steel that provides 50% more *effective* strength (50,000 psi minimum yield point) than structural carbon steel. It has four to six times the resistance to atmospheric corrosion, offers excellent workability and weldability, all at relatively low cost.

Payoff . . . By taking advantage of the unique properties of high-strength steel, designers were able to use thinner sheets for various structural members. The payoff is a unit that weighs about 500 pounds less, yet is stronger and can take more punishment than previous bulkier models. Less weight, naturally, can be translated directly into lower gasoline and operating costs.

COR-TEN Steel's outstanding resistance to atmospheric corrosion offers truck users another advantage. It has been proved that paint lasts longer on COR-TEN—and parts made of it seldom need refinishing.

Dollars and sense. It makes sense to put your dollars to work where they offer the greatest return. And when it comes to steel, you can't make a better choice than USS COR-TEN. For more information, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS and COR-TEN are registered trademarks

USS

United States Steel Corporation – Pittsburgh
American Steel & Wire – Cleveland
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Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Supply – Steel Service Centers
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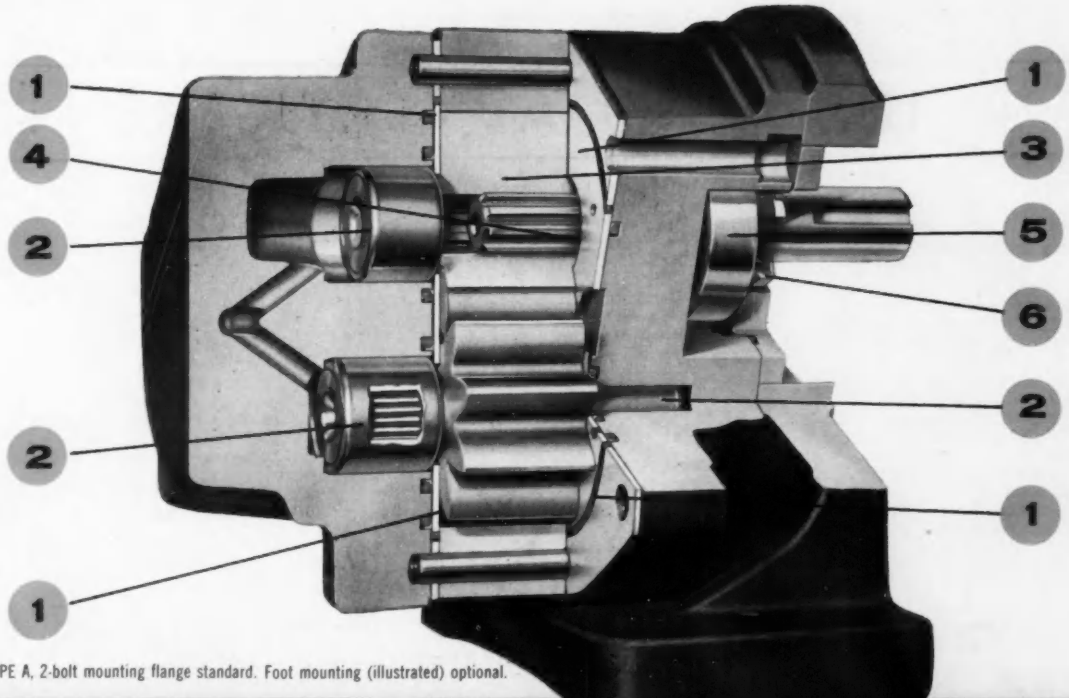

SAE TYPE A, 2-bolt mounting flange standard. Foot mounting (illustrated) optional.

SAVES UP TO 4 HORSEPOWER!

NEW WEBSTER "J" SERIES HYDRAULIC PUMP

HERE'S HOW WEBSTER PUTS NEW EFFICIENCY IN HYDRAULIC POWER . . . .

1 PRESSURE BALANCED WEAR PLATES — for high volumetric efficiency; prevents clearance changes due to heat.

4 FREE-FLOATING INTERNAL SPLINE DRIVES - no key failures.

2 NEEDLE BEARINGS — power-saving, anti-friction operation.

5 THRUST BEARING ON DRIVE SHAFT — absorbs compound driving thrusts.

3 ONE PIECE GEAR AND BEARING JOURNAL UNITS — assure minimum deflection and proper alignment on both drive and idler assembly.

6 DOUBLE LIP SEAL ON DRIVE SHAFT — gives added protection against seal failure and dirt.

Now — hydraulic power for your biggest mobile rig and the toughest jobs you can put it on. Webster's new "J" pump delivers 2000 psi — does it on less fuel and saves up to 4 horsepower in the bargain!

It's the result of a combination of pressure balanced wear plates and anti-friction bearings. Here's top efficiency from all-new Webster design that rates 10% or more above others in competitive ratings. Moreover, you get equally important advanced features (see sectional view) to assure dependable, trouble-free service.

Webster "J" series pump is trim, *very compact* — fits into tight quarters, mounts easily. It's available in 10 sizes from 5 to 40 gpm. Ask your Webster Electric representative for all the facts on this powerful new pump — or write direct for Bulletin HY1-1.

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC
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+ INDEX TO ADVERTISERS +

The workhorse bearings in the NEW Turbine Drive Buick "60" are HYATTS

From the transmission to the differential, you'll find Hyatt bearings taking the heavy loads in the new Turbine Drive Buick "60". Experience proves that Hyatt bearings are your best choice for automotive applications . . . or wherever heavy radial loads are encountered.

In Buick's differential carrier, a pair of Hyatt bearings are used to support and align the vital drive pinion. Another pair are used to support the ring gear and differential assembly. At the other end of the power train, you'll find Hyatt rollers are an integral part of the Buick transmission.

Take a leaf from Buick's notebook and you too will avoid taking chances with your product's reputation. Where bearing loads are heavy, remember . . . You are safer if your specs read Hyatt. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT *HY-ROLL BEARINGS*

IN ROLLER BEARINGS HYATT IS THE WORD FOR GM GENERAL MOTORS RELIABILITY

"Toughest" inspection in the steel business assures you utmost uniformity in Timken® forging steels

You can always be sure your forged products made from Timken® steel forging bars will have uniform quality. One big reason is the rigid, 100% Final Inspection we give every bar. Examination is so thorough that our Inspection Department is known as the toughest in the steel business.

You save money, too, because of the uniform quality of Timken steel. It is remarkably uniform in structure, chemistry and dimension from heat to heat, bar to bar, order to order. And because we handle each order individually, we can target our procedures to *your* end-use requirements. You don't have to interrupt your operations to make costly equipment adjustments.

Important to our operations is a new Metallurgical Research Center, one of industry's most modern. Its facilities range all the way from an experimental melting laboratory to one of the industry's finest technical libraries. It is designed not only to improve our own products but also to solve customer problems—your problems.

When you buy Timken steel you get: 1) *Quality that's uniform from heat to heat, bar to bar, order to order.* 2) *Service from the experts in specialty steels.* 3) *Over 40 years experience in solving tough steel problems.*

For the most from your modern forging operations, specify Timken steel forging bars. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

TIMKEN ALLOY STEEL AND SEAMLESS TUBING ARE AVAILABLE FROM WAREHOUSE STOCKS IN 44 CITIES IN THE UNITED STATES